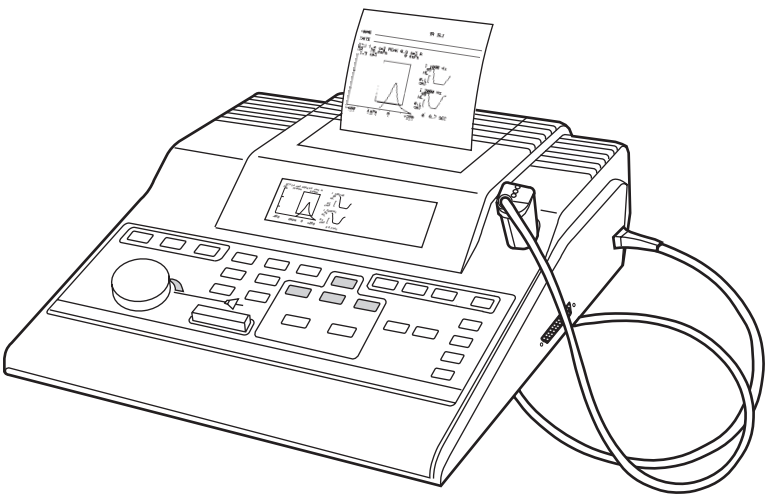
TM 262™ Auto Tymp™



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Section 1—Introduction

1.1 INSTRUMENT DESCRIPTION

The TM 262™ Auto Tymp™ is a versatile combination instrument which provides testing capability for tympanometry alone, tympanometry combined with screening acoustic reflex measurements, and manual audiometry. Two different versions are available to meet your individual testing needs. The basic version provides two modes of operation, tympanometry alone and tympanometry plus screening ipsilateral acoustic reflex testing. The second version adds manual audiometry. It is possible to field retrofit the manual audiometer to the basic version after the time of original purchase.

An RS-232 port is also available as an option. This allows the transfer of data from the instrument to a computer.

A soft-sided carrying case, a dust cover, patient handswitch, patch cords, and earphone sound enclosures may also be purchased as optional accessories (see page 60).

1.2 TYMPANOMETRY AND GRADIENT

1.2.1 Tympanometry

Tympanometry is an objective technique used since the late 1960's to measure the middle-ear function. During tympanometry, a low frequency tone (226 Hz) is presented to the ear canal via the probe. The probe tone is used to measure the compliance (admittance) changes within the middle-ear system while air pressure within the hermetically-sealed ear canal is changed from positive to negative. In the normal ear, positive pressure introduced into the ear canal space causes the middle-ear system to stiffen up or become less mobile. Because the pressure difference between the sealed ear canal space and the middle-ear space forces the tympanic membrane to stretch inward, this stiffened middle-ear system displays little or no compliance.

As the pressure within the ear canal is brought back toward atmospheric (ambient or 0 daPa) pressure, the pressure difference between the ear canal space and the middle-ear space is reduced in normal ears. At or near atmospheric pressure (0 daPa), the greatest amount of sound (probe tone) enters the middle-ear system. In other words, this is the air pressure value where the middle-ear system displays the maximum amount of compliance (admittance).

As negative pressure is introduced, a pressure difference is once again established and the middle-ear system becomes less compliant. Thus, by varying the pressure within the ear canal, it is possible to make a series of compliance measurements by means of the probe tone. The tracing which depicts these compliance changes is referred to as a tympanogram.

The point on the tympanogram which represents the point of maximum compliance (admittance) is the compliance peak of the tympanogram. The air pressure (pressure at the peak) where this compliance peak occurs approximates the pressure within the middle-ear system, since maximum mobility is only possible when there is little or no pressure difference between the ear canal and the middle-ear space. Compliance is measured with respect to the ability of an equivalent volume of air to conduct sound and the scientific quantity used is cm^3. Air pressure is measured in decapascals (daPa).

NOTE
1.0 daPa = 1.02 mm H_2O

The presence of a pathological condition which interferes with the mobility of the tympanic membrane, the ossicular chain, or the air pressure within the middle-ear space can be detected during tympanometry. For example:

- If the air pressure within the middle-ear space becomes negative due to a blocked Eustachian tube, tympanometry permits the measurement of this negative pressure and its effect on middle-ear compliance.
- If fluid builds up within the middle-ear space, this fluid will restrict the ability of the ossicular chain to conduct sound to the cochlea. If small air pockets exist within the fluid, the tympanogram will indicate the negative pressure where the restricted mobility occurs. With a totally fluid-filled middle-ear space, no mobility will be measured during tympanometry at any pressure value.
- In the case of a “glue-ear”, the ossicular chain is restricted in mobility but the air pressure within the middle-ear space is at atmospheric pressure. This tympanogram would depict a restricted compliance peak at or near 0 daPa.

1.2.2 Gradient

Gradient (width) measurements are used to describe the shape of a tympanogram in the vicinity of the peak. Often, the presence or absence of fluid in the middle ear is not clearly indicated by otoscopy and the tympanometric peak alone. This evaluation is especially difficult when the peak pressure is in the normal range.

The presence of fluid within the middle-ear space alters the shape of a tympanogram, i.e., makes the tympanogram wider near its peak. A larger-than-normal gradient can indicate the presence of fluid in the middle ear when other parameters are within normal limits. In this way, the gradient acts as an adjunct to the peak and ear canal volume measurements by helping to differentiate between tympanograms with similar peak values.

The TM 262™ Auto Tymp™ determines tympanometric width (gradient) by measuring the pressure interval at one-half of the peak height. Differing peak widths can point to different middle-ear conditions, even when peak height and pressure are within normal range. For example, middle-ear effusion brought on by secretory otitis media might result in an increased tympanogram width and, therefore, an increased gradient value. This would occur because the ossicular chain cannot react to the change in pressure introduced during the tympanogram in the same way that it would if the middle ear were properly aerated. The continued presence of effusion, leading eventually to a completely fluid-filled middle-ear cavity, will reduce the magnitude of the tympanogram to the point where no change in compliance is detectable across the pressure range. Under this condition, no gradient measurement is possible.

1.3 SCREENING ACOUSTIC REFLEX

An acoustic reflex occurs when a very loud sound (stimulus) is presented to the auditory pathway. During ipsilateral acoustic reflex testing, the stimulus is presented to the ear canal through the probe. This stimulus then travels through the middle ear to the cochlea. From the cochlea, frequency and intensity information are transmitted via the 8th nerve to the brain stem. If the intensity of the stimulus is high enough to elicit the reflex response, a bilateral response occurs, i.e., the right and left 7th nerves innervate their respective middle-ear muscles (stapedial muscles) causing them to contract. As these muscles contract, they stiffen their respective ossicular chains. This stiffening of the ossicular chain reduces the compliance of each middle-ear system. As in tympanometry, a probe tone is used to measure this decrease in compliance.

During ipsilateral acoustic reflex testing, both the stimulus and the probe tone are presented via the hand-held probe.

Acoustic reflex measurements are useful in determining the integrity of the neuronal pathway involving the 8th nerve, brainstem, and the 7th nerve. Since the acoustic reflex test is performed at high intensity levels and since it involves a measurement of middle-ear mobility, acoustic reflex testing is not a test of hearing.

The acoustic reflex test also serves as a good validation of tympanometric results, since an acoustic reflex cannot be measured in the absence of a compliance peak. In other words, if the tympanometric results indicate no mobility over the pressure range available with the TM 262, no reflex can be measured. If the test results indicate a reflex response in the absence of a compliance peak, one has cause to question the validity of the tympanometric test results. This indicates that the tympanogram should be repeated.

Clinical middle-ear instruments allow the measurement of the acoustic reflex threshold, since they provide the ability to manually change the intensity of the stimulus to a level where a reflex response is just barely

detectable for each patient tested. However, the TM 262™ Auto Tymp™ automatically presents the stimulus in a very definite stimulus intensity sequence. This preset intensity sequence may start at a level above an individual's acoustic reflex threshold level. Since the TM 262 uses a hand-held probe, noise from hand motion can be detected by the instruments circuitry. The magnitude of a detectable response must be somewhat higher than the criterion generally used during clinical acoustic reflex threshold testing, in order to avoid artifact caused by hand motion. Thus, the acoustic reflex measurements made with the TM 262 are referred to as screening acoustic reflex testing. The purpose of these screening reflex tests is to determine if a reflex is detectable or not, rather than to determine the lowest intensity at which the reflex occurs (i.e., threshold testing).

1.4 MANUAL AUDIOMETRY

While tympanometry and acoustic reflex measurements check the integrity of the middle-ear system, audiometry provides a means for checking the integrity of the entire auditory pathway. Manual audiometry provides a method to check an individual's ability to hear a test signal at a particular intensity level or at the lowest possible intensity level without the use of masking.

During threshold audiometry, the test signal is generally presented through an earphone to the ear under test. Different test protocols define the frequencies and intensity sequence to be used to obtain a response. Audiometric testing requires a behavioral response. This consists of having the individual raise a finger/hand or press a handswitch (optional) whenever the test signal is heard. The finger/hand is lowered or the handswitch is released when the test signal is no longer audible. Thus, the individual being tested must be able to understand a set of simple instructions and have the ability to provide some physical sign when the test signal is heard.

Section 2—Installation

2.1 UNPACKING AND INSPECTION

Examine the outside of the shipping container for any signs of damage. Notify your carrier immediately if any damage is observed.

Carefully remove your TM 262 from its shipping container. If the TM 262™ Auto Tymp™ appears to have suffered mechanical damage, notify the carrier immediately so that a proper claim can be made. Save all packing material so the claim adjuster can inspect it as well. When the carrier has completed the inspection, notify your Welch Allyn, Inc. distributor.

TABLE 2-1 Accessories Supplied

Probe Assembly	Test Cavity
Power Module or Internal Supply	Instruction Manual
Eartips (6 sizes, 2 each)	Test Headset (Models with audiometer only)
Paper (3 rolls)	

NOTE
Keep the original packing material and shipping container so the instrument can be well packaged if it needs to be returned for repair or calibration.

Inventory the accessories in Table 2-1. If any accessories are missing or damaged, notify your Welch Allyn, Inc. distributor or the factory immediately. See page 60 for a listing of optional accessories.

2.2 PROBE INDICATORS

The probe indicators are shown in Figure 2-1 and a description follows.

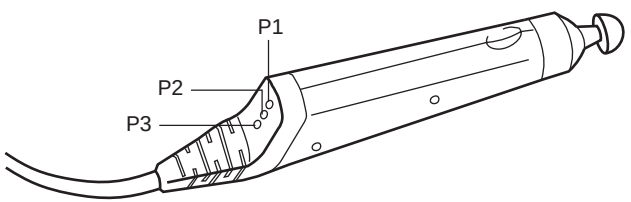


FIGURE 2-1: PROBE INDICATORS

P1 Yellow lamp: The probe is occluded; remove the probe and inspect for cause of occlusion

P2 Green lamp: Blinking—TM 262™ Auto Tymp™ is ready to begin a test
Steady green—test successfully started and in progress

P3 Orange lamp: A pressure leak has been detected

2.3 FRONT PANEL CONTROLS AND INDICATORS

The front panel controls and indicators are shown in Fig. 2-2 and are described follows.

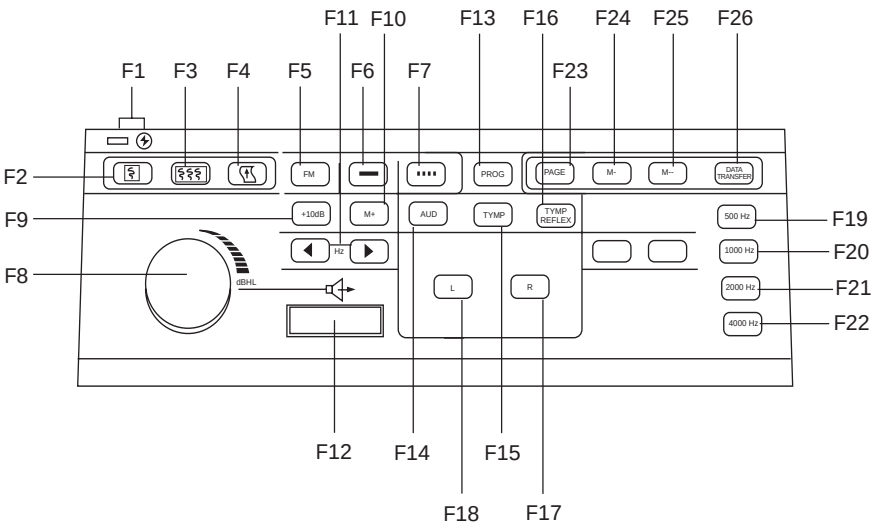


FIGURE 2-2: FRONT PANEL

F1 **Power:** Indicator is illuminated when the TM 262 is receiving power.

F2 **Print Screen:** Used to print the currently displayed page of memory.

F3 **Print All Memory:** Used to print all pages of data from memory.

F4 **Paper Advance:** Used to feed paper through printer.

F5 **FM:** Used during the Audiometry mode to select a frequency-modulated test tone. When the present bar is depressed, the letters FM appear on the display.

F6 **Steady Tone:** Used during Audiometry mode to select a continuous test tone. When present bar is depressed, the steady symbol appears on the display.

F7 **Pulsed Tone:** Used during Audiometry mode to select a pulsed tone. When the present bar is depressed, the pulsed tone symbol appears on the display.

F8 **Attenuator Knob (dB HL):** Used to increase or decrease the intensity of the test tone presented in Audiometry mode. Counter-clockwise rotation decreases the intensity. Clock-wise-rotation increases the intensity.

[+10 dB] **F9** **+10 dB:** Used to temporarily extend the audiometry intensity range by 10 dB. When selected, a large plus + sign appears on the display.

[M+] **F10** **Save:** During Audiometry mode, saves the threshold information (per frequency) on the display; during Program mode, selects a particular option; during Tymp/Reflex mode, stores a frequency as a default parameter.

◀▶ **F11** **< and > Hz:** Selecting Hz [◀] button causes the cursor to move to the next lower frequency; selecting Hz [▶] button, causes the cursor to move to the next higher frequency.

F12 **Present Bar:** Depress to present test signal to appropriate earphone; release to turn test tone off.

[PROG] **F13** **PROGRAM:** Depress to select Program mode screen which lists settings available for Reflex presentation format, printout header format, audiogram vs. tabular format, display normal box, and identify frequency range for Audiometry mode.

[AUD] **F14** **AUD:** Press to select Audiometry mode (available in models with audiometer only).

[TYMP] **F15** **TYMP:** Press to select Tympanometry only mode.

[TYMP REFLEX] **F16** **TYMP REFLEX:** Press to select Tympanometry and Reflex mode.

[R] **F17** **RIGHT:** Used to identify right ear under test so that data stored in memory and/or printed is properly identified; used to select right earphone for audiometry.

[L] **F18** **LEFT:** Used to identify left ear under test so that data stored in memory and/or printed is properly identified; used to select left earphone for audiometry.

[500 Hz] **F19** **500 Hz:** Selects 500 Hz as a stimulus during reflex testing.

[1000 Hz] **F20** **1000 Hz:** Selects 1000 Hz as a stimulus during reflex testing.

[2000 Hz] **F21** **2000 Hz:** Selects 2000 Hz as a stimulus during reflex testing.

[4000 Hz] **F22** **4000 Hz:** Selects 4000 Hz as a stimulus during reflex testing.

[PAGE] **F23** **PAGE:** Used to scroll through test results stored in memory.

[M-] **F24** **ERASE:** Used to erase currently displayed page of data from memory.

[M--] **F25** **ERASE ALL:** Used to erase all pages of data from memory.

[DATA TRANSFER] **F26** **DATA TRANSFER:** Used to transfer test results to an attached computer.

2.4 PRINTER AND LIQUID CRYSTAL DISPLAY (LCD)

The printer cover can be removed to reload paper (see Figure 2-3). Section 2.6.1 (page 12) provides paper loading instructions.

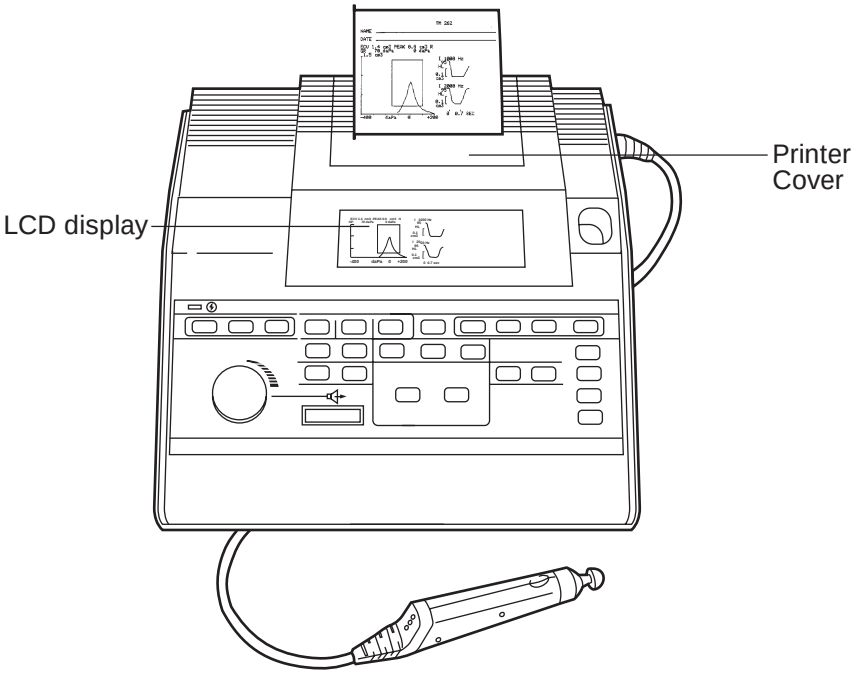


FIGURE 2-3: PRINTER COVER LOCATION

2.4.1 Liquid Crystal Display (LCD)

The display indicates test mode, parameters for test and test results. Figures 2-4 through 2-8 show the individual display format for each test mode.

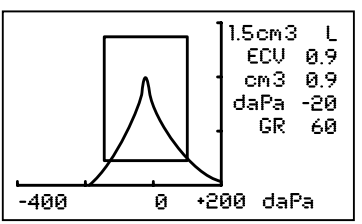


FIGURE 2-4: *Display format for* ***Tympanometry***

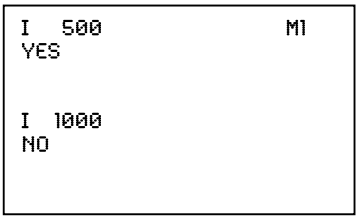


FIGURE 2-5: *Display format for* ***Reflex*** *test (results reported as "Yes" or "No").*

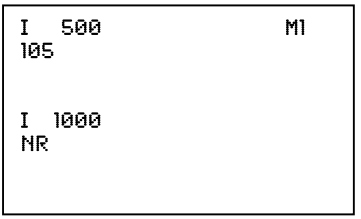


FIGURE 2-6: *Display format for* ***Reflex*** *test (results reported in "dB HL").*

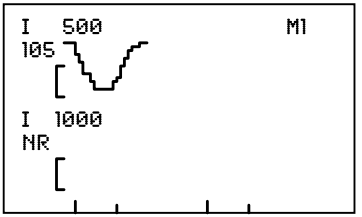


FIGURE 2-7: *Display format for* ***Reflex*** *test (results reported in "dB HL" and also shown with a "tracing").*

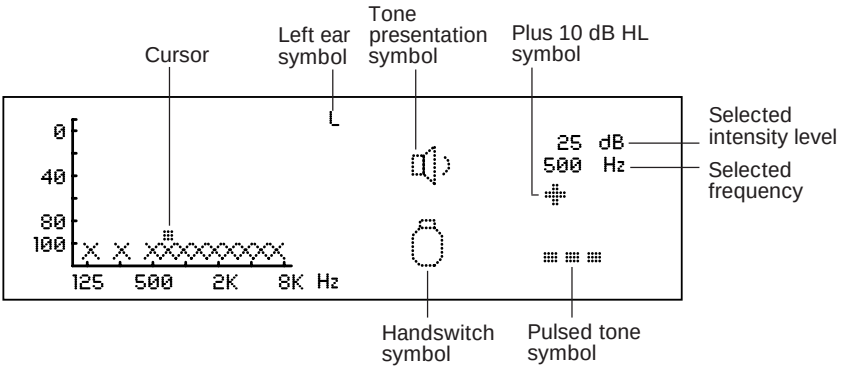


FIGURE 2-8: *Display format for* ***Audiometry***

2.5 REAR AND BOTTOM PANEL LABELS/CONNECTORS

The rear panel labels and connectors are shown in Figure 2-9 and a description of each one follows.

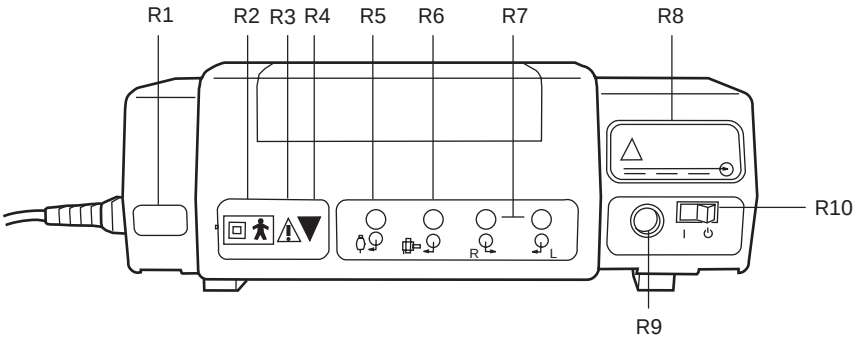


FIGURE 2-9: REAR PANEL

R1 Company name, address, model, serial number and country of origin.

R2 Symbol denotes a Type B, Class II Product per IEC 878 as referenced in IEC 601 Standard.

R3 Symbol denotes Attention, consult accompanying documents.

R4 Symbol indicates a service adjustment part that is intended for service personnel use only.

R5 Connector for handswitch. Input impedance (47 K ohms) pulls up to 5 volts.

R6 Contra Insert Phone. Function not available.

R7 Connectors for right and left earphones. 130 ohm, 2.50 volts rms maximum open circuit.

R8 Label describing low input voltage and current from wall mounted power supply.

R9 Power Input Jack. 5-pin DIN connector for external wall mounted power supply.

R10 Power Switch with ON/OFF indicators.

NOTE

Symbol on the bottom panel indicates entry by qualified service personnel only.

2.6 INITIAL SETUP

Place the TM 262™ Auto Tymp™ on a stable counter or table where it will subsequently be used, and near a properly grounded wall outlet. Attach accessories to their appropriately-labled connectors on the rear panel of the TM 262 (see Figure 2-9).

Locate the POWER switch on the rear panel of the TM 262 and move the switch to the ON (|) position. Note that the lamp (F1) on the front panel is illuminated, indicating the TM 262 is receiving power. The TM 262 symbol will then appear on the display along with a listing of the revision number for the Tymp/Reflex and Audiometry (if purchased) software. Next, the display will default to the Tymp/Reflex mode and the probe's green lamp will begin to blink, indicating that the TM 262 is ready to begin a test. If both the green and yellow lamps are illuminated at the same time, either the probe is occluded or the tymp/reflex software did not properly initialize. Simply move the power switch to the OFF (⏻) position, inspect the probe tip for any signs of an occlusion, and reposition the power switch to ON (|). If both green and yellow lamps are still illuminated and you are certain that the probe is not occluded, contact the Welch Allyn Technical Service Department (see page 55). In the meantime, it is still possible to select the Audiometry mode (if purchased).

Allow the instrument to warm-up for about five minutes before conducting a test. This allows the electronic circuits to stabilize prior to use. If the storage temperature is lower than the room temperature, allow some additional time for the instrument to reach room temperature.

Warning

The TM 262 is designed to be used with a hospital grade outlet. Injury to personnel or damage to equipment can result when a three-prong to two-prong adapter is connected between the TM 262 power plug and an AC outlet or extension cord. Additionally, those TM 262 Auto Tymps that are equipped with power transformers use a specific transformer (8000-0260, 8000-0261 or 8000-0262) which should not be interchanged with any other transformer or supply. The TM 262 is a specifically-calibrated device and the periodic service and adjustments which the instrument may require should be done ***only by an authorized Welch Allyn service technician.***

2.6.1 Loading The Paper

Remove the printer cover (see Fig. 2-3 for location) by placing your fingers along the back edge of the printer and pulling upward on the cover. Cut the printer paper so that the leading edge of paper is straight across. Place the roll of paper inside the paper well so that the paper will unroll from the lower surface. See paper loading label for additional help (Figure 2-11).

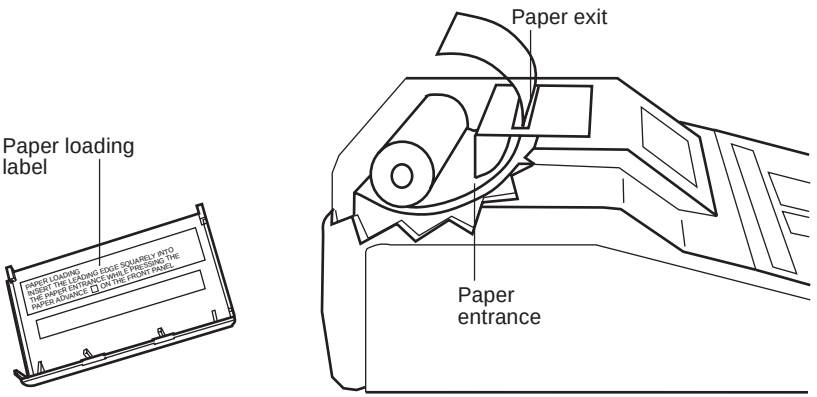

Paper exit
Paper loading label
PAPER LOADING
INSERT THE LEADING EDGE SQUARELY INTO THE PAPER ENTRANCE WHILE PRESSING THE PAPER ADVANCE ⊡ ON THE FRONT PANEL
Paper entrance

FIGURE 2-11: Paper Loading

Position the leading edge of the paper roll into the paper entrance while pressing the PAPER ADVANCE button. The paper will begin to appear out of the printer mechanism. Continue to advance the paper so that a section of paper is long enough to pass through the printer cover once it is repositioned over the printer.

2.6.2 Paper Storage

The TM 262™ Auto Tymp™ utilizes a thermal printer, which requires a heat-sensitive paper to create an image. For maximum paper life, any spare rolls of paper should be stored as follows:

1) Store in the dark, i.e., in a drawer or cabinet
2) Do not store above 77°F (25°C)
3) Store at less than 65% relative humidity

The above recommendations are for the maximum paper life (greater than five years). Storing your TM 262 thermal paper at high temperatures or high humidity levels will only shorten the total paper life.

2.7 PRETEST TYMPANOMETRY CHECKS

For your convenience, a test cavity is provided with your TM 262™ Auto Tymp™. This test cavity enables you to quickly verify the proper calibration of your unit. Welch Allyn, Inc. strongly recommends that you make this quick check a part of your daily routine.

2.7.1 Calibration

To initiate the quick check, select the Tymp only (TYMP) mode and insert the probe **(without a tip on it)** into the 0.5 cm^3 opening on the test cavity. See Figure 2-12.

NOTE

Since the TM 262 is designed to start automatically, it is important that the probe is inserted as quickly and as smoothly as possible. During the calibration check, the probe must be held carefully and without movement. Do not place the probe on the same counter as the instrument or any moving object during this check, as mechanical noise will be picked up by the probe and interfere with the calibration check.

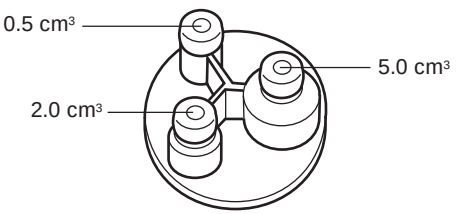


FIGURE 2-12: Test Cavity

The calibration check will start automatically if the probe has been inserted into the cavity properly. This is confirmed by the green lamp changing from blinking to a steady condition. If the orange lamp is illuminated, the probe is not properly positioned within the cavity so that a large pressure leak exists. If the yellow lamp is illuminated, the probe tip has been occluded. In either case, remove the probe and wait for the blinking green lamp. Insert the probe once again. Clean the probe tip if necessary (see Section 3.2).

When the test sequence is completed, the green lamp on the probe is no longer illuminated. Remove the probe from the test cavity and note that the green lamp is blinking once again. The display will indicate a flat line on the tympanogram along with the value of the test cavity next to the letters ECV (ear canal volume), i.e., 0.5. The letters NP will appear next to the labels cm^3 and daPa and three dashed lines will appear next to the letters GR (gradient). Since the test cavity is a hard-walled cavity, the tympanogram should be a flat line, indicating that there is no mobility in the system. The TM 262™ Auto Tymp™ places the letters NP next to the cm^3 and daPa headers to indicate that there is no peak compliance and, therefore, no peak pressure can be determined during the quick check. Also, since there is no compliance peak detected, it is not possible to calculate a gradient. Therefore, the TM 262 displays the dashed lines when a gradient calculation isn't possible.

Using the same sequence, place the probe in the test-cavity opening labelled 2.0 cm^3. Note that the display looks the same as with the 0.5 cm^3 measurement, except for the value placed next to the letters ECV (2.0). If you wish, the same sequence can be followed with the 5.0 cm^3 opening on the test cavity. To keep a record of this test-cavity-calibration check, simply press the PRINT ALL button on the front panel of the TM 262.

2.7.2 Altitude Adjustment

Since sound pressure will vary with altitude and barometric pressure, some variation from the 0.5, 2.0 and 5.0 cm^3 readings may be observed. Your TM 262 is carefully calibrated at our factory, which is at approximately 250 feet above sea level. If you are located at an elevation of 1000 feet or higher, your instrument may need to be recalibrated to account for your elevation. It is not necessary to recalibrate for barometric pressure changes on a daily basis. Just keep in mind that a change in barometric pressure (i.e., from low to high or high to low) will slightly affect the test-cavity readings.

The altitude calibration adjustment allows for "corrections" to the Ear Canal Volume (ECV) measurement and test cavity volume measurement for variations due to altitude. Because the TM 262 is a pressure-sensitive device which makes measurements relative to ambient air pressure, changes in air pressure due to weather or altitude will affect the Ear Canal Volume (ECV) read-out of the instrument. The slight pressure change resulting from changing weather conditions will usually yield volume read-outs within ±0.1 cm^3 of the expected cavity value; however, pressure changes due to altitude can shift these cavity values by as much as 30%. **These changes in pressure do not affect the accuracy of the compliance measurement system in any way.** But, many instrument operators prefer that their equipment give ECV values as they would appear at sea level. The altitude calibration mode allows the operator to adjust his/her Auto Tymp without the services of a qualified Welch Allyn Service Technician.

TABLE 2-2: Altitude Correction

Altitude Correction

Altitude (ft.)	Altitude Table (cm^3)
0 to 1,500	2.0
2,000 to 3,500	2.1 ± 0.1
4,000 to 6,000	2.2 ± 0.1
6,500 to 7,500	2.3 ± 0.1
8,000 to 9,000	2.4 ± 0.1
9,500 to 10,000	2.5 ± 0.1

The altitude calibration mode can only be entered when the TM 262 is powered up from its "off" state while the PROGRAM [PROG] mode button, is depressed. Hold the PROGRAM [PROG] button for approximately five seconds.

STEP 1

When entering the altitude mode the display will read as follows:

Altitude Mode
ECV 2.0
cm^3 9.99
Standard

(E71) is displayed in the bottom right corner of the display until the probe is in the 2.0 cm^3 cavity.

STEP 2

Place the probe into the 2.0 cm^3 cavity provided with the instrument and check cm^3 value against the altitude correction table for accuracy.

STEP 3

If the measured volume is not within the published table value ±0.1cc, then the operator should exit the altitude mode by pressing the PROGRAM [PROG] button and contact field service.

Providing the measured volume agrees with the published table ±0.1cc, the operator may proceed with the altitude adjustment.

STEP 4

With the probe still in the 2.0 cm^3 cavity, select the PAGE [PAGE] button to enter the custom calibration mode. Custom will appear on the fourth line of the display.

STEP 5

The value now displayed in the cm^3 display area is the volume measured and adjusted to the current altitude. If the value displayed is 2.0 cc, then the volume is adjusted to the current site. If the value is not 2.0 cc ±0.1, then press the SAVE [M+] button to customize the volume measurement to the current altitude. The measured volume should now read 2.0 cc.

STEP 6

To exit the altitude mode, press the PROGRAM [PROG] button to return to normal mode.

2.8 PRETEST AUDIOMETRIC CHECKS (Models with Audiometer Only)

2.8.1 Noise Recovery Period

Exposure to high levels of sound (e.g., unmuffled lawn mowers, loud music, gunfire) tends to create a Temporary Threshold Shift (TTS) which diminishes with time after exposure. Any subject tested soon after such exposure may exhibit a hearing loss that does not reflect his/her normal hearing threshold. This test procedure, therefore, generally prescribes a 16 hour interval between the last exposure to high-level sounds and the administration of any hearing test.

2.8.2 Elimination of Ambient Noise

Excessive noise in the test environment during audiometric testing, such as that produced by conversation, computers and public address systems reduces test validity because it tends to mask the test signals, particularly at the lower frequencies where earphone cushions provide less effective attenuation. An acoustically-treated room may be required if ambient noise reaches objectionable levels, i.e., sufficient to cause apparent hearing loss at the low frequencies. Also, earphone sound enclosures are available from Welch Allyn as an optional accessory. If the person being tested is in the same room as the audiometer, it is recommended that he/she be seated about three feet (one meter) away from the TM 262™ Auto Tymp™.

Maximum permissible noise levels are specified by the American National Standards Institute—Criteria for Permissible Background Noise during Audiometric Testing, ears covered with earphones (S3.1-1991 revised). Table 2-3 shows the maximum background levels that can be present inside the room while a valid hearing test is being conducted. For more comprehensive information about hearing testing and hearing conservation, refer to the Bibliography.

TABLE 2-3: Permissible Noise Levels

Test Tone Frequency (Hz)	125	250	500	750	1000	1500	2000	3000	4000	6000	8000
Test Room											
Ears covered maximum permissible octave band levels	34.0	22.5	19.5	21.5	26.5	26.5	28.0	33.5	34.5	38.0	43.5
Ears covered maximum permissible one-third octave band levels	29.0	17.5	14.5	16.5	21.5	21.5	23.0	28.5	29.5	33.0	38.5

2.9 BIOLOGICAL CHECK

To determine that your TM 262 is functioning properly, perform a daily check on a normal ear—your own if possible. This allows you to listen for the probe tone and the stimulus tone (during reflex) and determine if the air-pressure system is working properly. Keep a copy of your chart for a day-to-day reference in checking your TM 262.

If you purchased the TM 262™ Auto Tymp™ with audiometry, select the AUDIOMETRY [AUD] button located in the center section of the front panel. Note that the display changes to an audiogram format. The Hz [◄] and Hz [►] buttons allow you to select each frequency and the dB HL knob allows you to alter the intensity of each frequency. Position the test headset on your head so that each earphone is covering the appropriate ear (i.e., red is right and blue is left). Select the right earphone by pressing the front panel button labelled R and check for the following while depressing the present bar:

- Depressing the Hz [◄] button causes the frequency to change to a lower frequency, depressing the Hz [►] button causes the frequency to change to a higher frequency.
- Each frequency or tone is pure, i.e., there is no distortion or crackling sound present.
- Rotating the dB HL knob in a clockwise direction increases in intensity of the tone.
- Rotating the dB HL knob in a counter-clockwise direction decreases the intensity of the tone.

Section 3—Operation

3.1 EARTIP CARE

After the eartip is removed from the probe, it can be washed with warm soapy water to remove cerumen. Use an alcohol swab to disinfect the eartips. Be sure that the eartips are completely dry before reuse.

NOTE
Eartips may crack or otherwise deteriorate if left submerged in alcohol for a long period of time. Eartips should not be placed in an autoclave as they will melt and lose their shape.

3.2 PROBE CARE

With use, cerumen can work its way up inside the probe nose cone (probe tip). During the warm-up period each day and throughout the day, inspect the probe tip to make sure it is clean and free of cerumen. If any cerumen is detected, refer to the following instructions for cleaning and maintaining the TM 262™ Auto Tymp™ probe.

3.2.1 Probe Nose Cone Cleaning

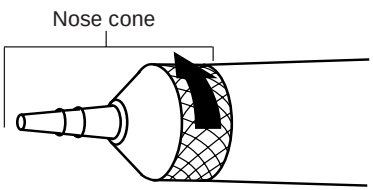


FIGURE 3-1: Probe Nose Cone Removal

Refer to Figure 3-1 and remove the nose cone portion of the probe as follows:

- Hold the body of the probe in one hand and grasp the nose cone of the probe in the other hand.
- Rotate the nose cone portion of the probe counter-clockwise until the nose cone is completely separated from the probe.
- Place the probe body securely on a table and inspect the nose cone for cerumen. Use a pipe cleaner to remove any cerumen by inserting the pipe cleaner through the back portion of the nose cone and pulling it through the front opening. It may be necessary to repeat this several times to remove all the cerumen.

NOTE
The probe nose cone can be sterilized via many conventional methods including autoclaving.

3.2.2 The O-Ring

There is an O-Ring seated at the end of the threads on the probe. As a preventative maintenance measure, and to ensure that the nose cone of the probe unscrews easily, do not clean or remove the lubricant from this O-Ring. If the O-Ring appears to be void of any lubricant, or if the nose cone itself was difficult to remove, apply the lubricant provided with the instrument (refer to Figure 3-2).

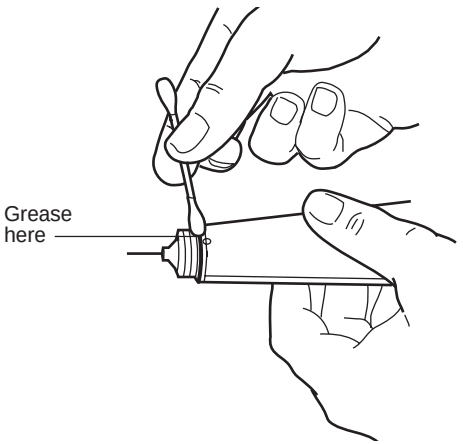


FIGURE 3-2: O-Ring Care

1. Place a small drop of lubricant at the front outer surface of the O-Ring.
2. Using the finger or a cotton swab, spread a thin layer of lubricant completely around the front and outer surface of the O-Ring. Assure that no lubricant spreads into the threaded area of the nose cone. Only a thin layer of lubricant is necessary. Excessive application or build-up may affect test results.

3.2.3 The Probe Wire

Inside the probe body there is a metal tube which contains a wire required for cleaning purposes. Carefully remove this wire from the metal tube (see Figure 3-3). This will pull any cerumen out of the metal tube. Examine the wire for cerumen. Clean the wire with a lint-free tissue, if necessary. Reinsert the wire into the metal tube and push it in as far as it can go. **The wire must be inserted into the metal tube for the TM 262™ Auto Tymp™ to function properly.**

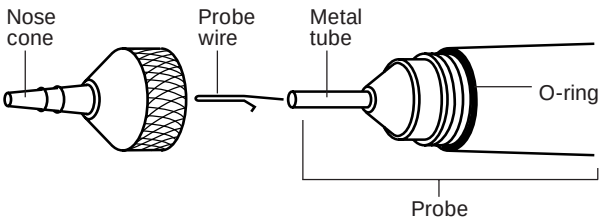


FIGURE 3-3: Probe Wire Removal

3.2.4 Probe Reassembly

Take care to align the threads on both the probe body and the nose cone before screwing the pieces together. Gently squeezing the two sides of the probe case together, screw the cone back onto the probe using a clockwise rotation. Only screw the nose cone on until it is finger tight. **The probe nose cone must be screwed firmly in place to prevent any air leaks.**

3.3 EARPHONE CARE (Models with Audiometer Only)

The earphone and cords provided with the TM 262™ Auto Tymp™ should last a long time with proper care. To clean the earphones and cords, use only a dry cloth or tissue. Moisture should not be allowed anywhere near an earphone itself, this can damage the diaphragm and grill cloth, requiring their replacement.

With extended use, earphone cords tend to fray internally at the connectors. This fraying will ultimately either decrease the signal level or cause the signal to be intermittent. To check for this problem, position the test headset over your ears and select a frequency (e.g., 1000 Hz) at 35 dB HL. Select the right earphone. While depressing the present bar, flex the earphone cord next to the connector at both ends. Listen for an intermittent signal, an abrupt change in signal intensity level or a scratchy sound superimposed over the selected frequency that coincides with the flexing of the cord. The presence of any of these conditions indicates that the cord should be replaced.

Also, examine the earphone cord for cuts or tears in the covering shield and the earphone cushion for signs of damage. If either problem is noticed, the earphone cord or cushion should be replaced. Both parts are easily replaced without the need for recalibration. However, if the earphone receives shock damage or is replaced for any reason, the TM 262 will need to be recalibrated.

Repeat this same sequence with the left earphone.

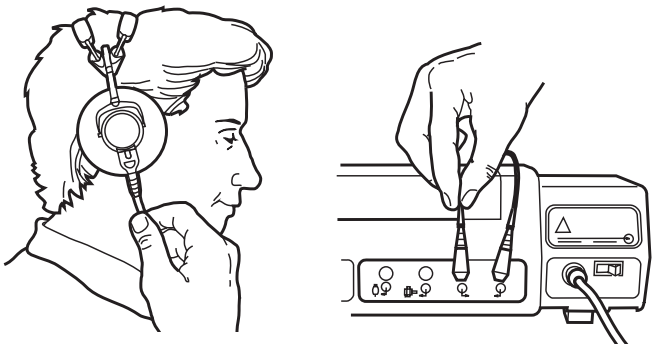


FIGURE 3-4: Earphone and Cord Care

3.4 PAPER SUPPLY

To streamline each testing session, check the amount of paper left inside the printer compartment, and keep extra rolls of paper so that the paper can be easily changed without upsetting your schedule.

NOTE

The number of tests per roll of paper will vary with the type of tests being performed. See pages 58 and 60 for approximations and paper ordering information.

3.5 TYMPANOMETRY TESTING INFORMATION

Perform a test on a normal ear each day to make certain that your TM 262™ Auto Tymp™ is functioning properly. See Section 2.9 for details.

3.5.1 Helpful Hints

Tympanometry and acoustic reflex testing can be performed at any age. However, the technique used will vary with age. From three years through adult, tympanometry can be performed with little difficulty due to the cooperative nature of this age group. With the under-three-year population, a bit of ingenuity is required to keep the patient relatively quiet during the seconds required for the test. In all cases, distraction is the key to success! Anything which provides a sound and/or visual distraction should work. Examples are only limited by your imagination!

Sucking on a pacifier or a bottle will help with the younger population. However, the tympanogram tracing will not appear as smooth due to the movement artifact. Having a parent hold an infant during testing will also help.

The key to success in all cases is to make sure that you are at **eye level** with the ear canal. Keep your hand steady and your eyes on the ear canal and probe lights until the test is over.

When first using your TM 262™ Auto Tymp™, practice on a cooperative patient to gain confidence in its use. Once you feel comfortable with the probe, you are ready to handle any situation. Remain calm and success will follow.

3.5.2 Obtaining a Seal

Six different size eartips are provided with your TM 262™ Auto Tymp™. Generally speaking, the following guidelines apply:

Age	Tip Size
Preemie	8 mm
Newborn	8 mm, 11 mm
Pre-school	11 mm, 13 mm
School age	11 mm, 13 mm, 15 mm
Adult	15 mm, 17 mm, 19 mm

Before attempting to seal the entrance of the ear canal, visually inspect the opening to make sure that the canal is free of any obstruction. If the canal is completely plugged at the entrance or if fluid is running from the ear canal, tympanometry should not be attempted until the condition is cleared.

NOTE

Damage to the probe can result if fluid is pulled up into the probe with negative pressure.

Slip the appropriate size eartip onto the nose cone of the probe, making sure that eartip is flush against the surface of the nose cone (see Figure 3-5).

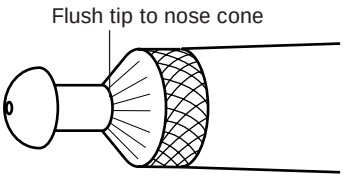


FIGURE 3-5: Positioning the Eartip

Before testing, clear any hair away from the ear and pull upward and back on the pinna. For a young child, pull downward and back on the pinna. This tends to straighten out the ear canal and ensure better results. Keep the pinna in this position throughout the test sequence. Make sure that the green lamp on the probe is blinking. Position the probe up against the entrance of the ear canal applying a **gentle** pressure to maintain a tight seal (see figure 3-6). **Watch the probe lamp.** As soon as a good seal is obtained, the green lamp will change from its blinking status to a continual status. This green light will remain on and steady while the test is in progress. Once the test sequence is over, all lamps on the probe will be turned off and the test result can be viewed on the instrument display before printing. The probe can now be removed from the ear canal.

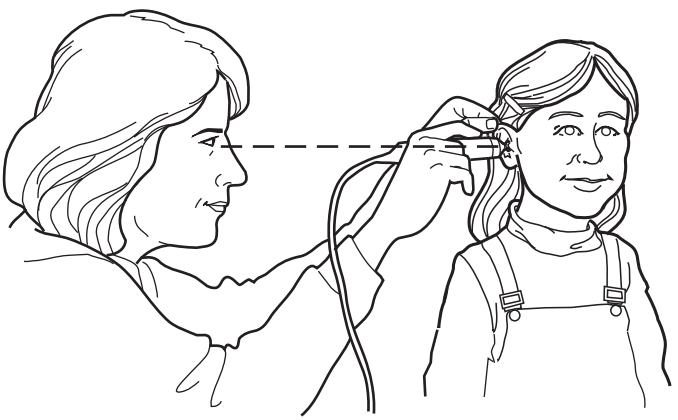


FIGURE 3-6: Positioning the Probe

The probe lamps will inform you of problems during testing as follows:

Yellow lamp: The probe tip is occluded with cerumen or you are pressing too hard against the ear canal so that you have collapsed the canal at the tip of the probe.

Green lamp: Still blinking—seal has not been obtained to initiate the test sequence.

Orange lamp: The ear canal is not properly sealed and a large pressure leak exists.

In all cases, it is best to remove the probe, examine the tip for cerumen and clean it, if necessary. A change of eartip size may also be appropriate. Start the test again!

3.6 AUDIOMETRY TESTING INFORMATION

Prior to testing, ensure that the earphone cords are plugged into their appropriate connectors on the rear panel of the TM 262™ Auto Tymp™. Select the desired tone type (pulsed, steady, or FM).

CAUTION

Always handle earphones with care. DO NOT drop them or allow them to be squeezed together. Severe mechanical shock may change their operating characteristics and require their replacement. Insert the earphone cords between the earphone cushions during storage to prevent damage from mechanical shock.

3.6.1 Instructing the Subject

The operator should put the subject as much at ease as possible before the test begins. In addition, it is important to ensure that the subject understands how the test is to be conducted and what he/she will hear. For sake of uniformity, an unvarying explanation is advisable—something close to the following:

> "I am going to place these earphones over your ears. You will hear a variety of tones—some high, some low, some loud, and some very soft. Whenever you hear, or think you hear one of these sounds, raise your hand. Lower your hand when you no longer hear the sound.
>
> "Remember that although some of the tones will be easy to hear, others will be very faint. Therefore, you should listen very carefully and raise your hand whenever you think you hear the tone."

Modify the instructions accordingly, if the optional handswitch is to be used.

3.6.2 Placement of Earphones

The most important thing to remember is that a good seal is required between the earphone cushion and the subject's head and ears. To increase the likelihood of a good seal:

a. Eliminate all obstruction between the earphones and the ears e.g., hair, eyeglasses, earrings, hearing aids, etc.

b. Adjust the headband so that it rests solidly on the crown of the subject's head and exerts firm pressure on both ears.

c. Center the earphones carefully over both ears. The earphone with the RED connector goes on the RIGHT ear. Take care to eliminate any visible gaps between the earphone cushions and portions of the individual's head and the ear on which the cushion rests.

3.6.3 Response Handswitch (Optional Accessory)

If the optional handswitch is to be used, be sure that the handswitch connector is properly inserted into the jack on the rear panel. The TM 262™ Auto Tymp™ will display an appropriate symbol ( ) whenever the handswitch is operated.

3.7 PROGRAM MODE

To enter the program mode, depress the PROGRAM PROG button located on the front panel. The following screen appears the first time you enter the Program Mode (the asterisks indicate the default settings).

PROG

Program Mode—User Selections

* Reflex HL + Curve	* Print—Audiogram
Reflex HL only	Print—Aud Table
Reflex Yes/No	* Normal Box ASHA
* Prn Header Welch Allyn	Normal Box Off
Prn Header Off	* Aud Range Normal
Prn Header Custom	Aud Range Narrow

Note that these selections fall into five different groups of controls:

Reflex format for printer

Print header format

Audiometric test result format

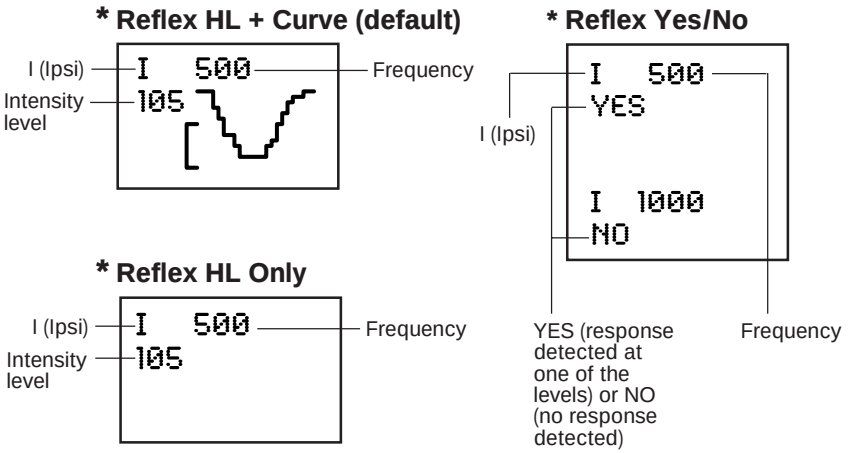
Status of normal box

Audiogram frequency range

The default setting for each group of controls has an asterisk (*) before it, so that it is easy to scan the settings selected for each group.

3.7.1 Reflex Format

Reflex test results can be displayed and printed in these three ways: Reflex HL + Curve, Reflex HL Only, or Reflex Yes/No.



To select a different setting for reflex format, note that a square cursor (▦) is located next to the reflex HL + curve option. Use the Hz [◄] button to cursor down to the setting that you wish to select for your own default criterion. When the square cursor is positioned in front of your desired setting, press the SAVE [M+] button. Note that the word SAVED appears in the lower right margin of the screen. Also, this will cause the asterisk (*) to be deleted from in front of the prior default setting (Reflex HL + curve), and to be repositioned in front of the new setting.

3.7.2 Print Header Format

Three different selections are available with respect to a print header: Print Header = TM 262; Print Header = Off; or Print Header = Custom. Print Header = TM 262 is the default setting for this feature.

*** Prn Header TM 262**

*** Prn Header Off**

*** Prn Header Custom**

Each time the PRINT SCREEN button or PRINT ALL button is chosen, the printout will begin with the label—Welch Allyn TM 262.

To deselect the Welch Allyn header and select No Header or a Custom Header, use a similar procedure to that described above. With the Hz ◄ or Hz ► button, position the square cursor in front of the desired new setting and press SAVE M+ to select it as the new default setting. The word SAVED appears in the lower right margin.

If the custom header is selected, a line cursor will begin to flash at the left-hand margin below the words Prn Header Custom. To “type” in the desired header use the dB HL knob. To sequence forward through the character set, rotate the knob in a clockwise direction. To sequence in reverse, rotate the knob in a counter-clockwise direction. The available character set is: A - Z; 0 - 9; and a blank space. The blank space can be used to erase an unwanted letter or number. A total of 35 character spaces are available. Please note, if you wish the header to be centered, it will be necessary to consider the length of the name to be inserted and calculate from the left margin where you want the header to begin. Otherwise, if you begin to enter the characters for the header from the left margin, the header will be printed from the left margin on the printout.

To move the cursor from the left-hand margin without inserting a letter or a number, select the character which represents a space (i.e., rotate the knob one position to left of the letter A). Use the Hz ► button to move over to the next character position. Repeat this sequence until the cursor is moved over to the desired start position for the first character to appear in your header. Rotate the dB HL knob to select the appropriate characters to spell out the desired header. After selecting each character, use the Hz ► button to move over to the next character position. Once all of the header characters have been added,

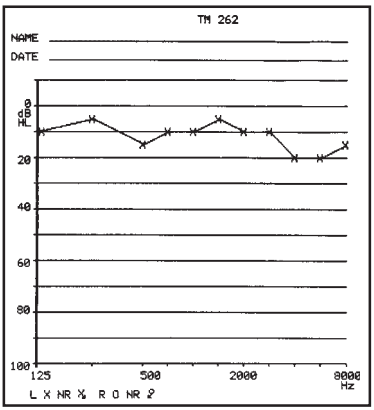
press the SAVE [M+] button to save your header in memory. The word SAVED will appear on the right-hand margin indicating that your header is now saved. The square cursor will reappear next to Prn Header Custom. It is now possible to exit the program mode or to sequence on to the next user selection. To exit the program mode, press the PROGRAM [PROG] button. Enter a single test result and select PRINT SCREEN [⎙] button to see how the custom header looks.

NOTE
If you had previously entered a custom header, position the square cursor next to the asterisk (*) in front of Prn Header Custom, press SAVE [M+] to cause the line cursor to appear at the left-hand margin along the bottom of the display. The word SAVED will appear at the lower right margin indicating that the custom header is still selected.

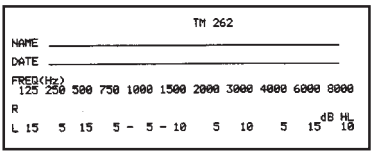
3.7.3 Audiometric Format During Printing

The audiometric test results can be printed out in an audiogram format (PRINT—AUDIOGRAM) or in a tabular format (PRINT—AUD TABLE). The default setting for this function is the audiogram format.

*** Print Audiogram**



*** Print Aud—Table**



NOTE
When a specific frequency is deselected for testing, the result will be a break in the audiogram line at that frequency. This eliminates the assumption that a threshold exists at that untested frequency.

To change the default setting to tabular format, move the Hz ◄ or Hz ► button to position the cursor in front of the description PRINT—AUD TABLE. Next, select the SAVE M+ button to save this format as the new default parameter. Note that the word SAVED appears in the lower right-hand corner of the display to indicate that this new setting has been saved. With PRINT—AUD TABLE selected, all audiometric test results will appear in a table with the frequency range typed horizontally along the top of the table followed by two lines of test data. The test results for the RIGHT ear will appear next to the letter R and below each frequency tested. Similarly, the test results from the LEFT ear will follow below the right ear results.

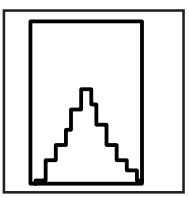
NOTE
This setting (PRINT-AUD) selects the format for the printout only. An audiogram always appears on the screen, while in this mode.

3.7.4 Normal Box Format

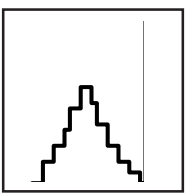
It is possible to have the normal box, as described by ASHA, appear on the tympanogram screen and printout. The boundaries for this normal box are –150 daPa to +100 daPa and 0.2 cm^3 to 1.4 cm^3.

NOTE
A compliance value of 1.5 cm^3 or greater will automatically turn off the ASHA normal box.

*** Normal Box ASHA**



*** Normal Box Off**



The normal box is the default setting. To deselect this normal box, move the square cursor with either the Hz ◄ or Hz ► button so that it is placed in front of the words Normal Box Off. Select the SAVE M+ button to save this feature as the new default setting. Note that the word SAVED appears in the lower right-hand margin.

3.7.5 Audiogram Range

All eleven frequencies are available during audiometry; however, the range can be abbreviated to eight frequencies. The default setting is Aud Range Normal.

*** Aud Range Normal**

125 Hz thru 8000 Hz

*** Aud Range Narrow**

500 Hz thru 6000 Hz

To select the abbreviated frequency range, position the square cursor in front of the feature Aud Range Narrow. Press the SAVE M+ button to save this narrow range for audiometric testing. Note that the word SAVED will appear in the lower right-hand margin and the asterisk now appears in front of the narrow range selection. If the narrow range is selected, the Hz ◄ and Hz ► buttons will allow you to scroll through this abbreviated frequency range only; however, the screen and printout will still be labelled with the full range of frequencies.

3.7.6 Exit Program Mode

Exit the program mode by selecting the PROGRAM PROG button. Note that you return to the test mode which was operational prior to entering the program mode.

3.8 TYMPANOMETRY ONLY MODE

To do only Tympanometry, press the TYMP (TYMP) button. The display will immediately show the format for the tympanogram along with the summary information headers: ECV, cm^3, daPa, and GR. The default scale for compliance is 1.5 cm^3. If a compliance peak greater than 1.5 cm^3 is measured, the TM 262™ Auto Tymp™ automatically scales the compliance axis to 3.0 cm^3 so that more of the tympanogram data can be seen.

Determine which ear is to be tested and select the appropriate ear button, RIGHT (R) or LEFT (L), so that the test results will be properly labeled. Examine the ear canal to determine the appropriate size eartip. Push the eartip as far down on the probe as possible, so that it is flush against the probe. Position yourself at eye level with the test ear. The blinking green lamp indicates that the TM 262 is ready to begin the test. Place the probe against the entrance of the ear canal so that its opening is completely covered, so that no visible leaks are apparent.

Once the TM 262 determines that a volume between 0.2 cm^3 and 6.0 cm^3 is present, the test sequence begins and the green lamp changes from a blinking to a steady state. From this point on, hold the probe securely in this same position without any hand motion. Keep your eyes on the probe and the individual's ear.

At the start of the test, the pressure system establishes a pressure of +200 daPa within the ear canal. When this pressure is achieved, the TM 262™ Auto Tymp™ makes a measurement of Ear Canal Volume (ECV). This information is valuable since it indicates if a good seal has been established and it helps differentiate between two similar tympanograms (i.e., a fluid-filled middle-ear system and a perforated tympanic membrane). After the Ear Canal Volume (ECV) is obtained, this compliance value is subtracted from the remaining compliance measurements so that a direct reading of the tympanogram compliance peak is possible.

The pressure sweep begins at the starting pressure of +200 daPa and proceeds in a negative direction at a rate of 600 daPa/second. Measurements of compliance are made continuously as the pressure sweep continues in a negative direction. The slope of the tympanogram increases as the measurement approaches the compliance peak. This signals the TM 262 to slow the rate of pressure sweep to 200 daPa/second to ensure a more accurate reading of the compliance peak. After the peak compliance and pressure values are detected and stored, the tympanogram dips downward toward the baseline and the pressure sweep rate returns to 600 daPa/second. The tympanometric sweep ends automatically when the compliance value returns to baseline and the pressure is at least –100 daPa. Only when the middle-ear pressure is very negative is it necessary for the pressure sweep to continue all the way down to –400 daPa. This automatic stop feature eliminates unnecessary pressurization of the ear and shortens the test time. When the test is completed, the solid green lamp turns off and the tympanogram results are displayed on the LCD.

In addition to the tympanogram tracing, the screen displays the test summary data: Ear Canal Volume (ECV), the compliance peak in cm^3, the pressure at the peak of the tympanogram in daPa, and the gradient (GR) as a pressure width value. The test results are automatically stored in a page of memory. The actual memory location number is determined by the number of tests which preceded this current test. For example, if this is the first test to be stored in memory, it will be assigned the number M1. If it is the third test to be stored in memory, it will be numbered M3 and so on.

This test result can be printed out immediately as a single test, by selecting PRINT SCREEN ONLY [ ] button. Other tests can be run and saved before all tests in memory are printed via the PRINT ALL [ ] button.

3.8.1 Exit Tympanometry Only Mode

To exit Tymp Only Mode, select Tymp/Reflex or Audiometry Mode. To enter the Tymp/Reflex Mode, press [TYMP. REFLEX].

3.9 TYMPANOMETRY AND IPSILATERAL REFLEX MODE

The default parameters for this test are tympanometry followed by an ipsilateral acoustic reflex test at 1000 Hz. To change this default setting, select the frequencies for the reflex test as described in Section 3.9.1.

Following the tympanometry sequence (see Section 3.8. for details), the test automatically sequences to the reflex portion of the test as follows:

The pressure from the tympanogram peak compliance is re-established within the ear canal and is offset by –20 daPa to avoid problems with extremely sharp tympanogram slopes. With the air pressure held constant throughout the reflex test sequence, the lowest intensity level for the starting frequency is presented and a measurement of compliance change is made. If the compliance decreases by at least 0.05 cm^3, this reflex intensity level is stored in memory, and the test is completed.

If no response is measured (i.e., a compliance decrease of at least 0.05 cm^3 was not detected) at this lowest intensity level, the intensity level of the stimulus is automatically increased by 10 dB and a measurement of compliance change is again made. If a response is detected, the test sequence for this frequency ends. If once again no response is detectable, the intensity level is increased by 10 dB (e.g., 1000 Hz Ipsi = 105 dB HL) and the stimulus is presented. After the compliance measurement is made and a response is detected, this highest intensity level is stored as the reflex test result and displayed on the screen. If no response is detectable at this third and highest intensity level, either a NO or an NR (depending upon Program Mode setting) is indicated on the screen next to the frequency tested label. If during any of the three stimulus presentations a large pressure leak develops, NT appears on the screen next to the tested frequency, and the test sequence is

aborted. If no other frequencies were selected for the test, the Tymp Reflex sequence ends here. The display will indicate the reflex test result as described in Section 3.7. Note that the green lamp is no longer illuminated indicating that it is time to remove the probe from the ear.

The same sequence is followed for each test stimulus selected, a maximum of three different stimulus intensity levels are available for the test. The test sequences through each of the intensity levels only if required to obtain a measurable result.

The three intensity levels available vary with the frequency selected as follows:

IPSI:	500 Hz	80, 90, 100 dB HL
	1000 Hz	85, 95, 105 dB HL
	2000 Hz	85, 95, 105 dB HL
	4000 Hz	80, 90, 100 dB HL

NOTE

Although four frequencies are available during the tymp and ipsilateral reflex test mode, most situations require only one or two frequencies to be tested. The TM 262™ Auto Tymp™ offers a selection from the most commonly used frequencies. However, it is strongly recommended that only one to two frequencies are tested, since holding the probe in the same position for the length of time it takes to test four frequencies sometimes becomes a problem for both the operator and the individual being tested.

3.9.1 Programming Ipsilateral Acoustic Reflex Test Frequencies

The TM 262™ Auto Tymp™ default is a 1000 Hz test stimulus. However, any combination of the four available frequencies (500, 1000, 2000, 4000 Hz) can be selected either temporarily or as revised default parameters. To temporarily modify the default condition, push the TYMP REFLEX (TYMP REFLEX) button, and then the desired frequencies by selecting or deselecting the appropriate frequency button. Each frequency selected will be indicated on the display as it is chosen. The lowest frequency will appear on the screen at the top of the first column for reflex results. Frequencies which follow will be ranked-ordered lowest to highest.

To change the default frequencies for the Tymp Reflex mode, select the desired frequencies as described above, then press the SAVE (M+) button. Note that the word SAVED appears on the display screen. Now every time that you re-enter the Tymp Reflex mode, these revised default parameters will automatically be selected. It is still possible to temporarily alter the frequencies selected by choosing the desired frequencies. However, each time that the Tymp and Reflex test mode is exited and re-entered, the default parameters will reappear. There is no limit to the number of times that the default frequencies can be modified.

3.9.2 Exit Tympanometry/Reflex Mode

To exit Tymp/Reflex Mode, select the Tymp Only or Audiometry Mode. Note that the appropriate screen appears on the display.

3.10 AUDIOMETRY TEST SEQUENCE (Models with Audiometer Only)

To enter the audiometry mode, push the AUD [AUD] button. Note that the display changes to an audiogram format. The default settings for the frequencies available during audiometry are 125 through 8000 Hz (normal), but can be changed to 500 through 6000 Hz (narrow) in the Program Mode (see Section 3.7).

Upon entering the audiometry mode, the starting signal is automatically a 1000 Hz, 0 dB HL continuous or steady tone. It is possible to temporarily change the signal format from this steady tone [—], to a pulsed tone [▪▪▪▪], or frequency-modulated (FM) tone [FM] by depressing the appropriate button. The display reflects the change with the appropriate symbol. These alternative tone formats remain selected during that particular audiometric test. Once any new test or test ear is initiated, the tone type returns to steady.

The audiometry test defaults to testing the right ear first. To start with the left ear, it is necessary to select the LEFT [L] button upon entering the audiometry mode.

To change frequencies, select the Hz [►] button to advance to higher frequencies, or the Hz [◄] button to advance to lower frequencies. Push once to advance one frequency, or hold the button down to scroll through the frequencies. Once the end of the frequency range is reached, the scroll will "wrap around" to the opposite end of the range, and continue advancing.

The value of the currently-selected frequency is always displayed on the LCD screen.

To change the intensity level of the test tone, use the dB HL knob. Rotating this knob in the clockwise direction causes the intensity level to increase in 5 dB steps; rotating it in the counter-clockwise direction causes the intensity level to decrease in 5 dB steps. Note that the cursor moves up and down accordingly and that the corresponding level appears on the screen above the frequency value.

For each frequency, there is a fixed intensity range normally available:

125 Hz	–10 to 50 dB HL
250 Hz	–10 to 70 dB HL
500 to 6000 Hz	–10 to 90 dB HL
8000 HZ	–10 to 70 dB HL

To extend the intensity range by 10 dB, push the +10 dB [+10 dB] button. This +10 dB [+10 dB] button may only be selected when the intensity level is set to the highest value in the normal range. For example, with the test

tone of 1000 Hz, the normal intensity limit is 90 dB HL. When the intensity knob is rotated clockwise beyond the 90 dB HL maximum, the intensity value on the LCD flashes. This indicates that the normal intensity limit has been reached. To go beyond 90 dB HL, push the +10 dB [+10 dB] button. A large + sign appears on the screen below the 1000 Hz value. Now, the dB HL knob can be rotated through two additional positions, 95 and 100 dB HL. If the dB HL knob is turned to the next position beyond 100 dB, the intensity value 100 flashes on the screen. This indicates that the maximum dB HL for the extended range has been reached. If the dB HL knob is rotated one more position beyond the flashing 100 dB position, the letters NR appear next to the letters dB. This permits the selection of the no response symbol NR (or) on the audiogram during testing. The extended range remains selected until the intensity level for that particular frequency is brought down 5 positions below the maximum dB HL value (e.g., 65 dB HL for 1000 Hz), or the frequency is changed.

To present a test tone to the selected test ear, press the present bar. A speaker symbol ( ) appears on the screen for as long as the present bar is depressed.

To save the threshold value for each frequency, press the SAVE [M+] button. Note that the appropriate symbol (O for right ear and X for left ear) is positioned at the correct location on the audiogram. If no response was detectable over the intensity range available, the appropriate symbol or appears.

It is possible to repeat a threshold check for any frequency by returning to that frequency using the Hz [◄] and Hz [►] buttons. In this instance, the last threshold obtained and saved with SAVE [M+] button becomes the value saved in memory and is the value printed out on the audiometric test results.

NOTE

Although the printout will combine the right and left ear test results on the same audiogram or table, the screen can display only the results from one ear at a time. Therefore, if the RIGHT [R] or LEFT [L] button is pressed while you are still testing a particular ear, the screen will change to a new audiogram. Once this happens, it is not possible to return to the incomplete audiogram to complete the test sequence.

3.10.1 Screening Audiometry

Carefully position the earphones over the individual's ears so that the RED phone covers the RIGHT ear and the BLUE phone covers the LEFT ear. Be sure that nothing is obstructing each earphone such as earrings, eye glasses or a hearing aid. Instruct the person being tested to raise a hand or a finger (or press the optional handswitch) whenever a tone is heard. Encourage him/her to respond, even if they are not sure whether they hear a tone.

Select the ear to be tested with the RIGHT [R] or LEFT [L] button. Next, select the desired screening intensity by rotating the dB HL knob to the appropriate position. The American Speech Language and Hearing Association recommends 20 dB HL as the screening level for school-aged children. Select the desired frequency at which to start the test by pressing the Hz [◄] or Hz [►] button. Present the selected tone via the present bar. If the individual fails to respond, increase the intensity by 10 dB and try again. Press the SAVE [M+] button at the intensity level where the individual responded. Continue the procedure for all the desired frequencies.

These results can be printed in an audiogram or tabular format. Check the Program mode to determine which setting has been selected.

3.10.2 Threshold Audiometry

1) Carefully position the earphones as described above, and select the ear to be tested first.
2) Familiarize the individual with the test protocol by presenting a tone of 40 dB HL at 1000 Hz.
3) Set HL control to -10 dB.
4) Practice: Beginning with the tone continuously on (Present Bar held down) gradually increase the intensity by turning the HL control until a response occurs. Switch the tone off for at least two seconds and present the tone again at the same level. If there is a second positive response, proceed to threshold measurement. If a second response does not occur, repeat this step. Practice is preliminary to threshold measurement determination and is to be completed at each new frequency setting.
5) The level of the first presentation shall be 10 dB below the level at which the subject responded during the familiarization procedure. Present the tone for a period of one or two seconds. Time between tones can be varied, but not shorter than the duration of the test tone itself. After each failure to respond to a signal, the level is increased by 5 dB until the first response occurs. After the response, the intensity is decreased 10 dB and another ascending series is begun.

   NOTE
   Descend in 10 dB steps and ascend in 5 dB steps.
6) The threshold is considered to be the minimum dial setting at which a response has occurred two times on an ascending scale.
7) Press the SAVE [M+] button to store the threshold level for a particular frequency. Note that the appropriate symbol (O = right, X = left) appears at the correct intensity level where the threshold was determined.
8) Repeat this test sequence for each frequency to be tested, typically 1000, 2000, 3000, 4000, 6000, 8000. Retest 1000 followed by 500 and 250. If there is a difference of 20 dB or more between two successive octaves, test the inter-octave responses, i.e. 750, 1500.
9) Once thresholds have been obtained for all the desired frequencies, select the other ear and repeat the sequence. Note that the display changes to a new screen for storing the second ear's results.

3.10.3 Exit Audiometry Mode

To exit the audiometry mode, select the Tymp mode or the Tymp/Reflex mode. Note that the appropriate screen appears on the display.

3.11 TESTS IN MEMORY

The Tymp and Tymp/Reflex test results are automatically stored in memory once the test sequence ends. Audiometric test results are stored in memory once the SAVE [M+] button is pressed. A total of eight memory locations or pages are available with the TM 262™ Auto Tymp™. Each test result is assigned a memory location number (M1 through M8) in the order the test was obtained .

To sequence through test results, press the PAGE [PAGE] button repeatedly. The memory location number for each page is located in the upper right-hand corner of each screen. If only five tests were stored in memory, only five memory locations can be scanned.

3.12 MEMORY ERASE

To erase a particular test result before printing, PAGE to the test result and press the ERASE [M-] button. The LCD displays a blank screen for erased memories with the memory location number located at the top right corner. Upon exiting the erase mode, the stored memories reshuffle and replace the empty memory with the remaining tests in the order in which they were run. To exit the erase mode, press the PRINT ALL [≋≋≋] or ERASE ALL [M--] buttons, or initiate a new test.

NOTE

When the erase mode is entered, a current audiogram is no longer accessible to change or to store new HL values. The instrument is programmed to default to the right ear at 0 dB and 1000 Hz upon selection of a new audiometric test.

To erase all tests from memory, press the ERASE ALL [M--] button. Be certain that you wish to remove all tests from memory before pressing the ERASE ALL [M--] button because the erasure occurs immediately upon pressing the ERASE ALL [M--] button!

3.13 PRINTING TEST RESULTS

The printout will begin with the header of your choice, (see Program Mode, Section 3.7). The next two lines contain space for entering the individual's name and the test date. This is followed by the test results in the order that they were obtained/selected.

Either a single test can be printed from memory or the entire group of tests in memory can be printed. To print a single test from memory, use the PAGE [PAGE] button to arrive at the desired test result, and press the PRINT SCREEN [≋] button.

To print all tests in memory, press the PRINT ALL button. When PRINT ALL is selected, and two audiogram tests are stored in memory, they will combine under the following conditions:

1) There must be one left test and one right test sequentially stored in memory and
2) A left and right audiometric pair of tests will not be combined if they are separated in the memory by a tympanometry test.

Therefore, when tests are erased, the resorting could cause a change in the Left/Right sequence with audiometric tests. The result would be that the wrong audiometric tests could be combined when PRINT ALL is selected. Prior to selecting PRINT ALL, the operator should scroll through the tests in memory noting where the audiometric tests are located, to avoid combining tests from different patients.

Section 4—Test Results

4.1 EAR CANAL VOLUME

NORMAL

As a general rule, values for ear canal volume should be between 0.2 and 2.0 cm^3. However, the normal values will vary with age and bone structure. With use, you will develop a feel for the appropriate values.

ABNORMAL

An ear canal value of less than 0.2 cm^3 indicates an abnormal condition. If the probe is partially plugged with cerumen or if the probe is positioned against the ear canal wall, a smaller-than-expected value will be measured. If an individual has a relatively large bone structure for his/her age, and a smaller-than-expected value is measured, the probe could be partially occluded or up against the canal wall. It is also possible to collapse the canal if the probe is held too firmly against it. Examine the tympanogram and the reflex results to confirm your suspicions. If they are abnormal, it is good practice to repeat the test.

An ear canal volume greater than 2.0 cm^3 also may indicate an abnormal condition. An important application of the ear canal volume measurement is to determine if there is a perforation of the tympanic membrane. If there is a perforation due to trauma or due to the presence of a pressure-equalization (P-E) tube, the measured ear canal volume will be much larger than normal since the TM 262™ Auto Tymp™ is measuring the combined volume of the ear canal and the middle-ear space.

4.2 COMPLIANCE PEAK

NORMAL

The range of normal compliance (admittance) is 0.2 cm^3 to approximately 1.4 cm^3. Some groups site a larger range of normal, up to 1.8 cm^3. A measured compliance peak within this range indicates normal mobility within the middle ear system.

ABNORMAL

A compliance (admittance) value of less than 0.2 cm^3 indicates a pathological condition as the middle ear system is stiffer than normal. To distinguish the probable cause of the stiffening, the pressure value where this stiffened compliance peak occurs needs to be considered. For example, normal pressure along with a stiff middle-ear system is indicative of a “glue-ear”, otosclerosis, a severely scarred tympanic membrane or a layer of plaque across the tympanic membrane. On the other hand, abnormal pressure along with a stiffened middle-ear system is consistent with a poorly functioning eustachian tube with possible effusion (serous otitis media).

NOTE
If the measured compliance value is less than 0.1 cm³, the TM 262™ Auto Tymp™ will print the letters NP next to the heading cm³ on the screen and printout. The letters "NP" indicate a poorly defined or flat tympanogram. The tympanogram may depict a very shallow peak.

A compliance value greater than 1.4 cm³ (or 1.8 cm³) indicates a hyperflaccid tympanic membrane or a possible disarticulation depending upon how far above the normal range the value is. Generally speaking, a compliance value of greater than 3.0 cm³ is indicative of a disarticulated ossicular chain. Further testing is necessary to confirm this suspicion.

NOTE
If a compliance value is measured to be greater than 1.5 cm³, the TM 262 automatically changes the range assigned to the graph and the tympanogram is traced to 3.0 cm³.

The validity of tympanometry and acoustic reflex testing is dependent upon a healthy tympanic membrane. A pathological condition at this membrane can mask the true condition of the middle ear.

4.3 PRESSURE PEAK

NORMAL
Strict rules for middle-ear pressure indicate a normal range of ± 50 daPa. However, for most applications, a normal range of –150 daPa to +100 daPa is used.

ABNORMAL
An extreme positive pressure condition is rare. Some researchers have reported high positive pressures at the onset of acute otitis media.

Pressure values more negative than –150 daPa are indicative of a poorly functioning eustachian tube. The severity of this condition is determined by the degree of negative pressure and its impact on the compliance peak.

If no pressure peak is measured over the pressure range of +200 daPa to –400 daPa, the letters NP will appear on the screen and the printout. This indicates that no pressure peak was detected over this pressure range.

4.4 GRADIENT

NORMAL
When testing a child, the normal range for the gradient is between 60 and 150 daPa (infants may show higher gradient values due to the mobility of their ear canals). The range of normal is somewhat narrower for adults, i.e. 50 to 110 daPa.

ABNORMAL

A high gradient value (greater than the high end of the normal range per age group) is indicative of middle ear effusion. The reduced compliance values and negative middle ear pressure characteristic of developing or resolving Otitis Media with Effusion (OME) will be manifested in a broad tympanogram with a large gradient value. However, abnormal gradient values may also be found in the absence of abnormal parameters. This could indicate a transient OME, so a retest after several weeks may be recommended.

When the middle ear's mobility is reduced to near 0 cm^3, due to viscous effusion or a "glue-ear" condition, no gradient value can be measured. In this case, the TM 262™ Auto Tymp™ will display dashes (---) next to the letters GR.

Very low gradient values are associated with a flaccid middle ear system. These low values should be taken into consideration with the ear canal volume and compliance peak values to determine the probable cause of the flaccid condition.

4.5 ACOUSTIC REFLEX

NORMAL

For screening purposes, a reflex measured at any one of the three levels available per frequency can be considered normal. Obviously, the lowest values are desired. However, without knowing the hearing threshold level of the individual for that frequency, it is difficult to make a more definite statement. Generally speaking, the reflex is reported to occur at between 70 and 90 dB HL above the hearing threshold in normal ears. Remember that these values apply to reflex threshold measurements and that the TM 262 does not permit reflex threshold measurements due to the use of a hand-held probe.

The presence of a reflex in the absence of a compliance peak suggests that the tympanometric results should be considered invalid and the test repeated. This is true because if there is no compliance measured during tympanometry, it is not possible to measure any stiffening affect during the reflex stimulus presentation.

ABNORMAL

If a pressure leak occurs during the reflex testing and the pressure system is unable to correct for this leak, the reflex test sequence is aborted. When this occurs, the test results are assigned the letters NT (not tested).

If no response is obtained at the third and final stimulus level, the TM 262 will indicate this with the letters NR or No. More detailed testing at the frequency where this occurred is required to determine the reason for the no response.

4.6 AUDIOMETRY

NORMAL

A normal response from a child should be at or below 20 dB HL. A normal response from an adult may be higher, at or below 25 dB HL. These normal values assume a sufficiently quiet environment during testing.

ABNORMAL

In children, a failure to respond to a 20 dB HL (or lower) stimulus presentation during a retest performed four to six weeks after the initial test, would indicate the need for more extensive diagnostic testing to determine the cause.

In adults, a failure to respond at or below 25 dB HL when the room noise levels are low, indicates the need for more evaluation. However, the age and employment history of the individual must also be considered.

4.7 SPECIAL MESSAGES AND ERROR CODES

Special messages and error code numbers may be displayed on the screen or on the printout. Special messages appear to apprise the operator of certain situations. For example, if there is no test result on the screen and the PRINT SCREEN button is pressed, the printer will indicate “No Test To Print”.

An error code appears as a two-digit number prefixed by the letter “E”. If an error code appears, repeat the operation that caused the error code to appear. If the error code appears for the second time, contact Welch Allyn with the exact error code number.

4.8 SAMPLE TEST RESULTS

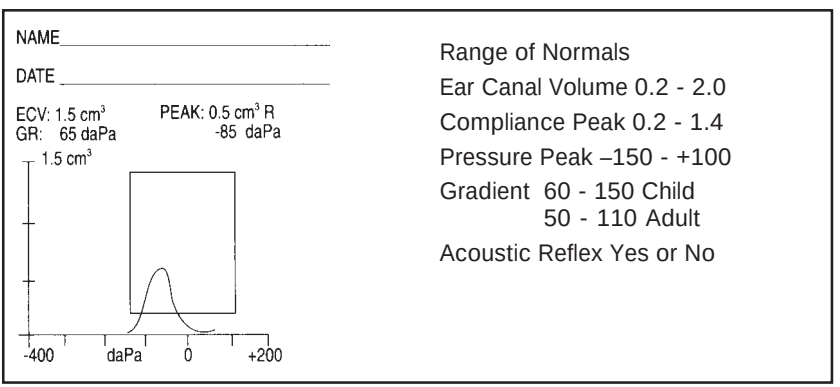
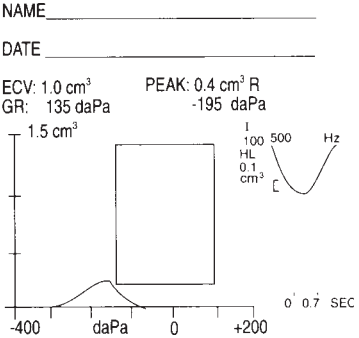


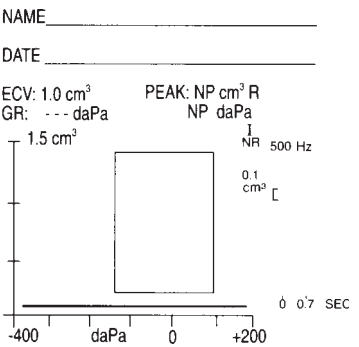
FIGURE 4-1: RANGE OF NORMALS



Normal Ear Canal Volume
Restricted Mobility
Abnormal Middle-Ear Pressure
Borderline Wide Gradient
Slightly Elevated Reflex

POSSIBLE CAUSE
Poorly functioning eustachian tube

FIGURE 4-2: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume

No Mobility

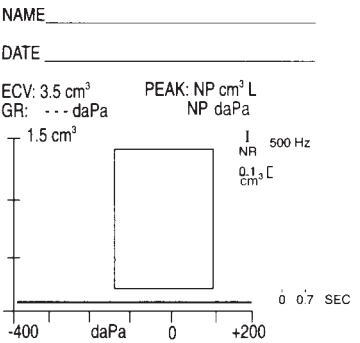
No Middle-Ear Pressure

No Gradient

No Reflex

POSSIBLE CAUSE
Fluid-filled middle-ear (Serous Otitis)
Compliance peak may be present at a more negative pressure than –400 daPa

FIGURE 4-3: ABNORMAL TYMPANOMETRIC RESULT



Abnormal Ear Canal Volume

No Mobility

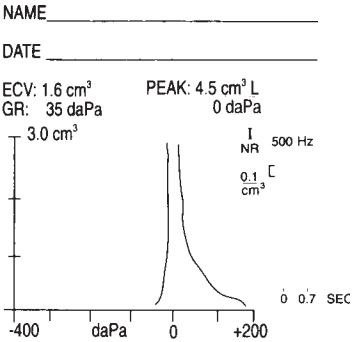
No Middle-Ear Pressure

No Gradient

No Reflex

POSSIBLE CAUSE
Perforation
Patent Pressure Equalization (P-E) tube

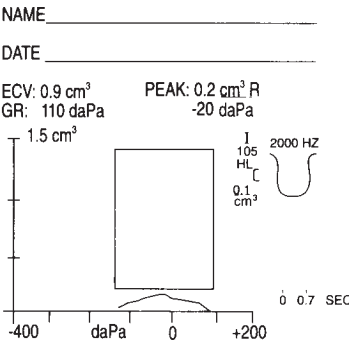
FIGURE 4-4: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume
Extremely Hyperflaccid Middle-Ear
Normal Middle-Ear Pressure
Narrow Gradient
No Reflex

POSSIBLE CAUSE
Ossicular disarticulation
more detailed testing indicated

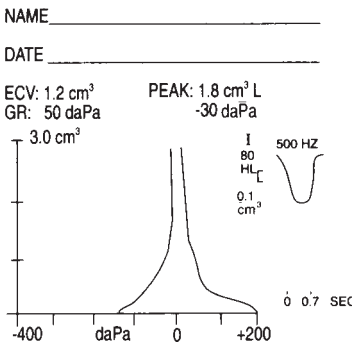
FIGURE 4-5: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume
Normal Middle-Ear Mobility
Normal Middle-Ear Pressure
Borderline-or-Wide Gradient
Slightly Elevated Reflex

POSSIBLE CAUSE
Glue-Ear
Otosclerosis
Severely scarred tympanic membrane
Plaque over tympanic membrane

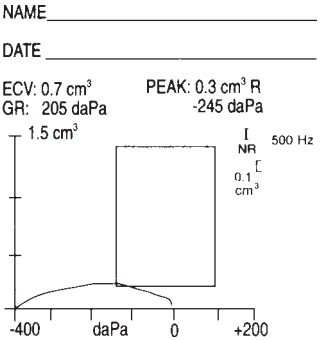
FIGURE 4-6: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume
Hyperflaccid Middle-Ear System
Normal Middle-Ear Pressure
Normal-or-Borderline Narrow Gradient
Normal Reflex

POSSIBLE CAUSE
Minor scar tissue in tympanic membrane

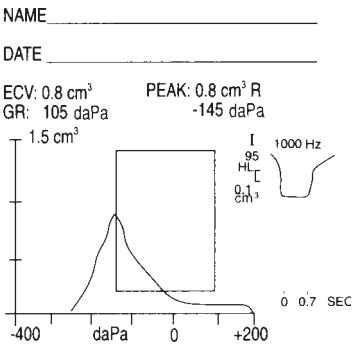
FIGURE 4-7: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume
Restricted Mobility
Negative Middle-Ear Pressure
Abnormally Wide Gradient
Elevated or No Reflex

POSSIBLE CAUSE
Serous otitis media
Small air pockets present

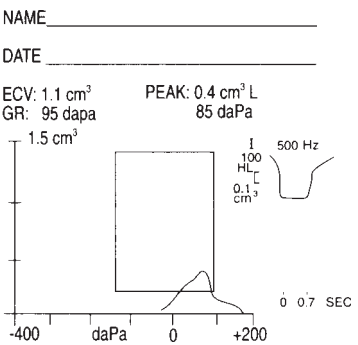
FIGURE 4-8: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume
Normal Middle-Ear Mobility
Slightly Negative Middle-Ear Pressure
Normal Gradient
Normal to Slightly Elevated Reflex

POSSIBLE CAUSE
Partially blocked eustachian tube

FIGURE 4-9: ABNORMAL TYMPANOMETRIC RESULT



Normal Ear Canal Volume
Normal Middle-Ear Pressure
Positive Middle-Ear Pressure
Normal Gradient
Elevated Reflex

POSSIBLE CAUSE
Patient has a cold

FIGURE 4-10: ABNORMAL TYMPANOMETRIC RESULT

Section 5—RS-232 Interface

5.1 INTRODUCTION

The TM 262 RS-232 Interface option provides the capability of transferring stored test results from the TM 262 to an external computer or data collection device via an optically isolated serial interface.

5.2 OPERATION

Press the DATA TRANSFER (DATA TRANSFER) button, located on the front panel (see figure 2-2, page 6) of the instrument, to transfer test results stored in memory. During data transfer the message DATA TRANSFER will appear on the LCD screen.

TRANSFERRING DURING NORMAL OPERATION

During normal test operation, the DATA TRANSFER (DATA TRANSFER) button will sequentially transfer all stored test results. The test results are transferred with one record for each memory location in the order in which they are stored. Any test results which have been erased will not be transferred.

TRANSFERRING FROM MEMORY PAGES

If the PAGE (PAGE) button is used to review individual test results stored in any of the eight memory locations, the DATA TRANSFER (DATA TRANSFER) button will transfer only the currently-displayed stored test results. There is one exception to this rule: If the last (most recent) test result is displayed, the instrument assumes normal testing operation, and transfers all test results.

OTHER LCD SCREEN MESSAGES

The message INVALID SELECTION appears if the DATA TRANSFER (DATA TRANSFER) button is pushed during any of the following circumstances:

- During presentation of an audiometric tone
- During a tympanometry test
- During a reflex test
- During printing

The message NO DATA AVAILABLE appears if the DATA TRANSFER (DATA TRANSFER) button is pushed and no results are stored.

The message NOT AVAILABLE appears if the DATA TRANSFER (DATA TRANSFER) button is pushed and the RS-232 interface is not installed.

5.3 RECORD FORMATS

5.3.1 General Record Format

All output records are transmitted in a predefined, fixed length format. The generic format for all records is:

":"	Record Type	Record Sequence Number	Record Index Number	Total Record Number	Data Fields	Checksum	"CR" "LF"

Each record contains only printed ASCII characters, other than the terminating "CR" "LF" characters.

Each record consists of fixed length data fields with any unused data fields filled with a value of 0.

The Record Sequence Number is a value from 0 to 9 which is incremented by 1 for each new record which is transmitted. This value will wrap around from 9 to 0. A record will be retransmitted with the same sequence number if retransmission is necessary due to a communications error.

The Record Index Number is a value from 0 to 8 which indicates the record number within a group of records when all test results are transmitted. For example, this value will identify a record as Record 1 of 5 or Record 7 of 8 when used in conjunction with the Total Record Number. If only the currently displayed record is being transferred, this value will be 1.

The Total Record Number is a value from 1 to 8 which indicates the total number of records to be transmitted in a group when all test results are transmitted.

The Checksum is calculated as the mod 256 sum of all preceding characters in the record, including the ":" prefix, with the most significant bit = 0 and stored as two Hex ASCII characters.

5.3.2 Tympanometry and Reflex Test Results Record

Character Number	Number of Characters	Data Type	Field Name	Field Description
1	1	ASCII	Start of record	":"
2	1	ASCII	Record Type	"x"
3	1	ASCII	Record Sequence Number	"0" to "9"
4	1	ASCII	Record Index Number	"1" to "8"
5	1	ASCII	Total Record Number	"1" to "8"
6	5	ASCII	Reserved	Reserved for future use. Defaulted to "-----"

Character Number	Number of Characters	Data Type	Field Name	Field Description
11	2	uChar	Ear	Ear under test Bit 0 =1=Left ear under test =0=Left ear not under test Bit 1 =1=Right ear under test =0=Right ear not under test Bits 2-7=Not used Either the RIGHT ear is selected OR the LEFT ear is selected. Both ears selected or no ear selected is invalid.
13	4	ulnt	ECV	Ear canal volume in cm3 measured at +200 daPa, stored as ECV X 64. Range=0.00 to 6.00 cm3
17	4	ulnt	Peak Compliance	Peak compliance in cm3, stored as compliance X 64. Range=0.00 to 6.00 cm3
21	4	slnt	Peak Pressure	The pressure where the peak compliance occurred, stored in daPa. Range=-399 to 200 daPa
25	4	slnt	Gradient	Gradient value calculated as the pressure difference at the compliance half-peak points stored in daPa. Range=-1 to 600 daPa. -1=No gradient has been calculated yet. 0=No gradient could be calculated.
29	2	sChar	End Index	The data index where the last compliance data point is stored. Range=-1 to 87 -1=No data was stored.
31	2	sChar	Slow Index	The data index where the last compliance data point measured at 600 daPa/sec before the rate changes to 200 daPa/sec is stored. -1=No rate change occurred.
33	2	sChar	Fast Index	The data index where the first compliance data point measured at 600 daPa/sec after changing back to 600 daPa/sec from the 200 daPa/sec rate is stored. -1=No rate change back occurred.
35	2	uChar	Tymp Data [0]	Tympanometry compliance data point #0 in cm3, stored as: compliance X 64. Range=0.00 to 3.98 cm3. A maximum of 88 data points are stored per Tympanometry test.
:	:	:	:	:
209	2	uChar	Tymp Data [87]	Tympanometry compliance data point #87 in cm3, stored as: compliance X 64.
211	2	uChar	Tymp Scale	Tympanometry compliance axis scale. 15=1.5 cm3 30=3.0 cm3

Character Number	Number of Characters	Data Type	Field Name	Field Description
213	2	uChar	Number of Reflex Tests	The number of reflex tests performed. Range=0 to 4
215	2	uChar	Reflex Test Parameters	Reflex test selection parameters. Bit 0=Ipsi status: 0=Not selected 1=Selected Bit 1=Contra status: 0=Not selected 1=Selected Bit 2=500 Hz status: 0=Not selected 1=Selected Bit 3=1000 Hz status: 0=Not Selected 1=Selected Bit 4=2000 Hz status: 0=Not Selected 1=Selected Bit 5=4000 Hz status: 0=Not selected 1=Selected Bits 6 & 7=Not used
217	2	uChar	Reflex #1 Result	Results of Reflex test #1. Bits 1 & 0=dB level tested: 00=Low dB level 01=Middle dB level 10=High dB level 11=Invalid Bits 3 & 2=Reflex tests status: 00=NT=Not tested 01=YES=Yes, a reflex was detected 10=NR=No reflex detected 11=NT_CAL=Not tested, due to a calibration data error Bits 5 & 4=Test frequency: 00=500 Hz 01=1000 Hz 10=2000 Hz 11=4000 Hz Bit 6=Test type: 0=IPSI 1=CONTRA Bit 7=Not used
219	4	ulnt	Reflex #1Baseline Average	Average baseline compliance, in cm3 X 256
223	4	ulnt	Reflex #1 Reflex Average	Average reflex compliance, in cm3 X 256
227	4	ulnt	Reflex #1 Reflex [0]	Reflex compliance data point #1 of 4, in cm3 X 256. Bit 15=Noise indicator 0=Quiet data measurement 1=Noisy data measurement, potentially unreliable
:	:	:	:	:
239	4	ulnt	Reflex #1 Reflex [3]	Reflex compliance data point #4 of 4, in cm3 X 256. Bit 15=Noise indicator 0=Quiet data measurement 1=Noisy data measurement, potentially unreliable

Character Number	Number of Characters	Data Type	Field Name	Field Description
243	4	ulnt	Reflex #1 Recovery [0]	Reflex recovery compliance data point #1 of 6 measured after the stimulus is turned off, in cm3 X 256. Bit 15= Noise indicator 0=Quiet data measurement 1=Noisy data measurement, potentially unreliable
:	:	:	:	:
263	4	ulnt	Reflex #1 Recovery [5]	Reflex recovery compliance data point#5 of 6 measured after the stimulus is turned off, in cc X 256. Bit 15=Noise indicator 0=Quiet data measurement 1=Noisy data measurement, potentially unreliable The recovery points #5 and #6 are only included when the recovery is slow and there was no recovery according to the first four recovery data points. If not included, their values will be 0.
267		asst	Reflex #2	See Reflex #1 format.
317		asst	Reflex #3	See Reflex #1 format.
367		asst	Reflex #4	See Reflex #1 format.
417	2	uChar	Checksum	The hexadecimal sum of characters 1 to 416
419	2	ASCII	Package Terminator	“CR”, “LF”

5.3.3 Audiometry Test Results Record

Character Number	Number of Characters	Data Type	Field Name	Field Description
1	1	ASCII	Start of record	“:“
2	1	ASCII	Record Type	“y”
3	1	ASCII	Record Sequence Number	“0” to “9”
4	1	ASCII	Record Index Number	“1” to “8”
5	1	ASCII	Total Record Number	“1” to “8”
6	5	ASCII	Reserved	Reserved for future use. Defaulted to “-----”

Character Number	Number of Characters	Data Type	Field Name	Field Description
11	2	uChar	Ear	Ear under test Bit 0=1=Left ear under test =0=Left ear not under test Bit 1=1=Right ear under test =0=Right ear not under test Bits 2-7=Not used Either the RIGHT ear is selected OR the LEFT ear is selected. Both ears selected or no ear selected is invalid.
13	4	slnt	HL Threshold 125 Hz	-10 to +100 dB HL x 2 NR=Any value in the range of 231 to 450 NT=32,768 (0x8000 Hexadecimal)
:	:	:	:	:
53	4	slnt	HL Threshold 8000 Hz	-10 to +100 dB HL x 2 NR=Any value in the range of 231 to 450 NT=32,768 (0x8000) Hexadecimal)
57	2	uChar	Checksum	The hexadecimal sum of characters 1 to 56
59	2	ASCII	Package Terminator	“CR”, “LF”

5.3.4 Notes

1) “uChar” & “sChar” designate unsigned and signed characters respectively, single bytes represented in Hexadecimal by two ASCII characters.

   Example: 0xE9 is sent as: “E”, “9”

2) “ulnt” and “slnt” designated unsigned and signed 16-bit integers respectively, expressed in HiByte / LowByte sequence by four Hex ASCII characters.

   Example: 0xE196 is sent as: “E”, “1”, “9”, “6”

3) Tympanometry compliance values are stored in the record scaled by 64. To convert to cm3, divide by 64.

   Example: Tymp Data [0]=“4”, “2” = 0x42=66 decimal scaled X 64=66 / 64=1.03 cm3

4) Reflex compliance values are stored in the record scaled by 256: To convert to cm3, divide by 256.

   Example: Reflex #1 Reflex [0]=“0”, “3”, “0”, “D”=0x30D =781 decimal scaled X 256=781 / 256=3.051 cm3

5) Audiometry Threshold values are stored scaled by 2 in the sequence of 125 Hz, 250, 500, 750, 1000 \, 1500, 2000, 3000, 4000, 6000 and 8000 Hz.

   Example: HL Threshold 125 Hz=“0”, “0”, “9”, “6”=0x96 =150 decimal scaled x 2=150 / 2=75 dB HL.

6) The pressure at which a Tympanometry compliance value was measured at is not contained in the data record but may be calculated.

   At the start of each pressure sweep, the pressure sweep rate is 600 daPa/sec. If the compliance begins to rapidly increase, the pressure sweep rate changes to 200 daPa/sec and remains at that rate until the compliance rate of change has sufficiently slowed down to allow the pressure sweep rate to return to 600 daPa/sec.

   While the pressure sweep rate is 600 daPa/sec, a compliance data point is stored at every 12 daPa drop in pressure and at 200 daPa/sec a compliance data point is stored at every 3 daPa drop in pressure. The Slow Index and Fast Index values in the data record indicate where the pressure sweep rate changes, if any, occurred.

7) Reflex compliance values are stored in three groups: 1 Reflex Baseline Average value which is the reference measurement performed before the stimulus is presented, 4 Reflex compliance data points which are measured while the stimulus is presented and stored as the relative compliance change from the Baseline Average value, and 4 to 6 Reflex recovery compliance data points which are measured after the stimulus is turned off and stored as the relative compliance change from the Baseline Average value.

5.4 DATA TRANSMISSION PROTOCOL

The TM 262 RS-232 Interface uses an Auto Repeat Request (ARQ) communications protocol to insure the reliable transfer of data. With this protocol, the TM 262 will transmit a data record and then wait for a response from the external device. If the external device receives the record correctly, it should respond with an acknowledge “ACK” character (ASCII control character ACK). If the record is not received correctly, the external device should respond with a not acknowledge “NAK” character (ASCII control character NAK).

If an ACK is received by the TM 262 within 3 seconds of the completion of the transmission, the transmission has been successfully completed. The DATA TRANSFER message disappears and normal operation resumes.

If after the transmission of a record there is no response within three seconds, the record is retransmitted with the same Record Sequence Number. If such a timeout occurs after the second attempt then the message NO RESPONSE is displayed, any pending transmissions are aborted, and normal operation resumes.

If a NAK response is received during a transmission or within three seconds after the transmission is completed, the record is retransmitted with the same Record Sequence Number. If the transmission is not acknowledged within three attempts the message TRANSFER NOT

COMPLETE is displayed for about three seconds, any pending transmissions are aborted, and normal operation resumes.

The NAK responses and timeouts are treated independently. Thus, when a combination of errors is happening, the NAKs and timeouts are being counted separately. If the transfer is not successful, the error message displayed corresponds to the failure condition which occurs first.

The only expected response from the external device to the TM 262 is an ACK or a NAK character.

When a series of records are transmitted, the external device must ACK or NAK after each response.

5.5 DATA TRANSFER PROGRAM MODE

The Data Transfer Program mode is used to modify the RS-232 interface configuration parameters to match the computer's RS-232 parameters. To enter the Data Transfer program mode, first enter the User Selection Program Mode by selecting the PROGRAM [PROG] button. Then select the DATA TRANSFER [DATA TRANSFER] button. The following screen appears the first time the Data Transfer Program mode is entered showing the default settings set at the factory:

Program Mode—Data Transfer	
19.2 kBAUD	* NO PARITY + 8-BIT DATA
* 9600 BAUD	ODD PARITY + 7-BIT DATA
4800 BAUD	EVEN PARITY + 7-BIT DATA
2400 BAUD	SPACE PARITY + 7-BIT DATA
1200 BAUD	* XON/XOFF FLOW DISABLED
600 BAUD	XON/XOFF FLOW ENABLED

These selections fall into three different groups of control:

- Baud rate
- Parity and data bits
- Flow control

The default setting for each group has an asterisk (*) before it so that it is easy to scan the settings for each group.

Selecting different default settings for any of the groups is done in the same manner as the Program mode. Use the <Hz [◄] or >Hz [►] buttons to move the solid square cursor down or up to the setting that you wish to select and press the SAVE [M+] button. The word SAVED will appear in the lower right margin of the screen and the asterisk (*) will be repositioned in front of the new setting.

Exit the Data Transfer Program mode by selecting either the DATA TRANSFER [DATA TRANSFER] or PROGRAM [PROG] buttons. This will return to the User Selection Program mode which can be exited by selecting PROGRAM a second time.

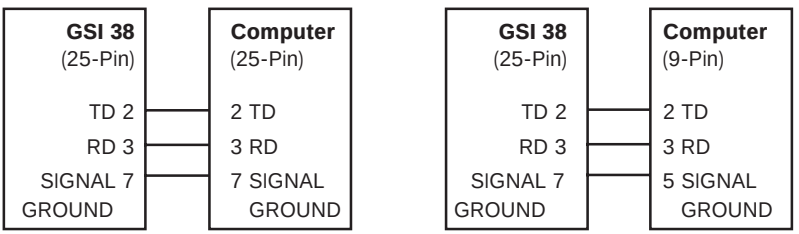
5.6 RS-232 INTERFACE

5.6.1 Interface Configuration

The configuration of the TM 262 RS-232 interface must be set to match the interface configuration of the computer. The TM 262 defaults to 9600 baud, no parity, 8 data bits, 2 stop bits and no communications flow control. The default settings for the baud rate, parity, number of data bits and flow control may be modified using the Data Transfer Program mode explained in Section 5.5.

5.6.2 Cable Connections

The TM 262 RS-232 interface provides a serial interface consisting of RxD (Received Data) and TxD (Transmitted Data) using a standard DB-25 female connector. A straight through cable can be used to connect to either a 25-pin or 9-pin (using appropriate adapter) connector on the external device.



5.6.3 Communications Flow Control

Software XON / XOFF flow control is available to allow software commands from the external computer to start and stop the flow of data from the TM 262. No hardware flow control is provided.

Sending XOFF (ASCII control character [DC3]) to the TM 262 pauses its transmission.

Sending XON (ASCII control character [DC1]) to the TM 262 resumes the transmission.

Once XOFF is received by the TM 262, XON must be received within six seconds. If not received within this time then the message NO RESPONSE is displayed for about three seconds, transmission is aborted, and normal operation resumes.

After an XOFF timeout, the next transmission waits for XON to be received within six seconds as described above.

These commands are valid only during data transmission and when enabled in the Data Transfer Program Mode.

Service and Warranty Information

SERVICE AND REPAIR

Repair must be performed by authorized personnel. Failure to do so invalidates the TM 262™ Auto Tymp™ warranty.

For customers in North America or Canada, please contact Welch Allyn for information regarding where to return your TM 262 Auto Tymp for service:

Technical Service Department
Welch Allyn, Inc.
1 Westchester Drive
Milford, NH 03055-3056
North America
Tel.: 1-800-535-6663
(In North America only)

Technical Service Department
Welch Allyn Canada Limited
160 Matheson Boulevard, East
Mississauga, Ontario, Canada L4Z 1V4
Tel.: 1-800-561-8797
(In Canada only)

WARRANTY

Welch Allyn, Inc. warrants the TM 262 Auto Tymp, to be free of original defects in material and workmanship and to perform in accordance with manufacturer's specifications for a period of one year from the date of purchase. If this instrument or any component thereof is found to be defective or at variance from the manufacturer's specifications during the warranty period, Welch Allyn will repair, replace or recalibrate the instrument or component(s) at no cost to the purchaser.

This warranty only applies to instruments purchased new from Welch Allyn or its authorized distributors or representatives. The purchaser must return the instrument directly to Welch Allyn or an authorized TM 262 distributor or representative and bear the costs of shipping.

This warranty does not cover breakage or failure due to tampering, misuse, neglect, accidents, modification or shipping, and is void if the instrument is not used in accordance with manufacturer's recommendations or if repaired or serviced by other than Welch Allyn or a Welch Allyn authorized representative.

No other express or implied warranty is given.

Return of the instrument registration card is required for proof of purchase and warranty validation.

Specifications

STANDARDS:

IEC 601-1 Medical Electrical Equipment Requirements for Safety

CSA C22.2 No. 601-1-M90 Electromedical Equipment, Warnock Hersey Listed

ANSI S3.39-1987 Aural Acoustic Impedance Admittance (Type 3)

IEC 1027-1991 Aural Acoustic Impedance/Admittance (Type 3)

ANSI S3.6-1989 Audiometers (Type 4)

IEC 645-1 Pure Tone Audiometers (Type 4)

TYMPANOMETRY/REFLEX MODES:

Probe Tone: 226 Hz, ± 3%

Sound Pressure Level: 85.5 dB SPL, ± 2.0 dB, measured in a 2.0 cm^3 coupler

Harmonic Distortion: <5%

Admittance (Compliance) Range: 0 to 1.5 cm^3

0 to 3.0 cm^3

NOTE:

1. The range is automatically selected based upon the amplitude of the compensated (tymp only) tympanogram.
2. The maximum uncompensated (ECV + tympanogram peak) admittance (compliance) range is 0 to 5.0 cm^3.
3. ECV/cavity limits for initiating pressurization is 0.2 to 6.0 cm^3.

Compliance Accuracy: ± 0.1 cm^3 or ± 5%, whichever is greater

PNEUMATIC SYSTEM

Pressure Range: +200 to –400 daPa

NOTE:

1. 1 daPa = 1.02 mm H_20
2. Pressure sweeps to at least –100 daPa. To save test time, pressure sweep stops once tympanogram returns to baseline after –100 daPa.
3. Full pressure sweep for 6 cm^3 from sea level to 7000 ft. altitude with no leak.

Pressure Accuracy: ±10 daPa or ±15%, whichever is greater

Rate of Sweep: 600 daPa/sec except near tympanogram peak where sweep rate slows to 200 daPa/sec to provide better definition of peak compliance.

Direction of Sweep: Positive to negative

Tympanometric Test Time: approximately one second

NOTE:
High compliance tympanograms will take somewhat longer

Gradient: Tympanogram pressure width at 50% of peak compliance.

ACOUSTIC REFLEX STIMULI:

Frequencies: 500, 1000, 2000, and 4000 Hz

Accuracy: ±3%

Total Harmonic Distortion: <5%

Rise/Fall Time: 5 to 10 msec

Output Levels:

IPSI: 500 and 4000 Hz:80, 90, 100 dB HL

1000 and 2000 Hz: 85, 95, 105 dB HL

NOTE:

1. Ipsi stimuli are time multiplexed with probe tone (106 msec ON, 53 msec OFF).
2. Stimuli are presented at lowest level first. If there is no response, the intensity is increased by 10 dB until a response is detected or the maximum dB HL is reached.

Pressure: Automatically set to pressure at peak compliance with an offset of –20 daPa.

Reflex Determination: Compliance change of 0.05 cm^3 or greater.

Reflex Test Time: 1 to 12 seconds depending upon the number of ipsi test frequencies selected (four maximum) and intensity required.

Probe LED Indicators:

Steady yellow: occlusion

Blinking green: ready to start testing

Steady green: test in progress

Steady orange: leak

AUDIOMETRY MODE (Model No. 26230, No. 26230-RS, No. 26235 and No. 26235-RS only— marked "Version 4")

Frequencies: 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, 8000 Hz

Accuracy: ± 3%

Total Harmonic Distortion: < 3% (125 to 3000 Hz measured acoustically at maximum dB HL; 4000 & 6000 Hz measured electrically)

Intensity Levels: 125 Hz: –10 to 50 dB HL

500 to 6000 Hz: –10 to 90 dB HL

250 and 8000 Hz: –10 to 70 dB HL

NOTE:
An additional +10 dB is available per frequency via the +10 dB button.

Accuracy: 125 to 4000 Hz ±3 dB

6000 and 8000 Hz ±5 dB

Step Size: 5 dB

Signal-to-Noise Ratio: > 70 dB in 1/3 octave; less than –10 dB HL for levels less than 60 dB HL

Rise/Fall Time: 20 to 50 msec

Tone Format (tone is normally off until present bar is depressed):

Continuous: steady when present bar is depressed

Pulsed: 2.5/sec (i.e., 200 msec ON, 200 msec OFF)

FM (frequency modulated): 5 Hz, ±5%

TRANSDUCERS

IPSI: Welch Allyn design

Audiometric Headset: Pair TDH-39 earphones with MX41AR cushions (60 ohms impedance)—Models No. 26230, No. 26230-RS, No. 26235 and No. 26235-RS only (marked "Version 4")

PRINTER

Paper Roll Length: approximately 80 feet (960")

Tests/Roll: Tymp and Reflex = 420 tests or 210 people

Tymp and Reflex plus one audiogram = 230 tests or 115 people

Speed: approximately 1.5 minutes to print three screens (including audiogram).

POWER

Line Voltage: 120 V (±10%) or 220 V (±10%) or 240 V (±10%)

NOTE:
Wall mount power supply or internal power supply depending upon country.

Frequency Range: 50 to 60 Hz (±5%)

Line Voltage Current: 0.2 amps at 120 V or 0.1 amps at 240 V AC

Power Consumption: 15 watts maximum while printing.
Low voltage input for wall mount power supplies 10 to 11 VDC 970 mA.

ENVIRONMENTAL

Temperature:

Operating:	60° F to 105° F	Storage:	–40° F to 140° F
	15° C to 40° C		–40° C to 60° C

NOTE:
Warm-up time is required if storage temperature is different from room temperature.

Humidity: 5% to 90%

MECHANICAL

Dimensions: 13.15" W x 14.5" D x 4.3" H
33.66 cm W x 35.56 cm D x 9.53 cm H

Weight: 10 lbs (4.5 kg) net
14 lbs (6.4 kg) shipping

SUPPLIED ACCESSORIES	CATALOG NUMBERS
Instruction Manual	#1738-0101
TDH-39 Headset (Models #26230/#26235 Only)	#23223
Test Cavity	#26241
Eartips (6 sizes, 2 each)	#26100
Paper — 3 rolls thermal 4" (10.16 cm wide)	

OPTIONAL ACCESSORIES	CATALOG NUMBERS
Carrying Case	#05260
Dust Cover	#26240
Earphone Sound Enclosures	#23222
Eartips	
8mm,1 box of 25	#26008
11mm,1 box of 25	#26011
13mm,1 box of 25	#26013
15mm,1 box of 25	#26015
17mm,1 box of 25	#26017
19mm,1 box of 25	#26019
Replacement Paper (5 rolls/box)	#52600
Patch Cord (1)	#23221
Response Handswitch	#23220
RS-232 Cable Adaptor (DB-25 M/ DB-09 F)	#26244
RS-232 Cable (10'–DB-25 M/F straight through)	#26243

CATALOG LISTING	WITHOUT RS-232 PORT	WITH RS-232 PORT
TM 262 Auto Tymp with Ipsi Reflex (North America)	#26200	#26200-RS
TM 262 Auto Tymp with Ipsi Reflex (**export**, specify country and voltage)	#26205	#26205-RS
TM 262 Auto Tymp with Ipsi Reflex and Manual Audiometer (North America)	#26230	#26230-RS
TM 262 Auto Tymp with Ipsi Reflex and Manual Audiometer (**export**, specify country and voltage)	#26235	#26235-RS

GLOSSARY OF TERMS

Acoustic Reflex — reflex arc elicited in the presence of very loud sounds which causes a decrease in middle-ear compliance as a protective mechanism for the cochlea.

Compliance Peak — the point of maximum mobility in a tympanogram which indicates the degree of mobility within the middle-ear system.

Ear Canal Volume — volume measured between the tip of the probe and the tympanic membrane at the starting pressure for a tympanogram.

Ipsilateral Acoustic Reflex — the acoustic reflex elicited when the stimulus is presented to the same ear where the response is measured.

Manual Threshold Audiometry — a hearing test performed with a variety of frequencies and intensities without the use of masking to determine if an individual can hear.

Normal Box — range of pressure peak and compliance peak values associated with normal middle-ear function (–150 daPa to +100 daPa, 0.2 cm^3 to 1.4 cm^3 per *ASHA*, 32, Supl. 2, 1990, 17-24).

Pressure Peak — pressure value where maximum mobility occurs in a tympanogram. This pressure value approximates the pressure within the middle-ear space.

Probe Tone — low frequency (226 Hz) tone used to measure middle-ear mobility.

Tympanogram — the tracing which depicts the results of tympanometry.

Tympanometry — an objective measurement of middle-ear mobility and middle-ear pressure through the use of a low frequency sound (probe tone) and air pressure changes.

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